

4.7 Parallel and Perpendicular Lines

Objectives

In this section, you will learn to:

- Distinguish between different types of slopes.
- Identify parallel lines by their slopes.
- Graph parallel lines.
- Identify perpendicular lines by their slopes.
- Graph perpendicular lines.
- Write the equation of parallel and perpendicular lines.

To successfully complete this section, you need to understand:

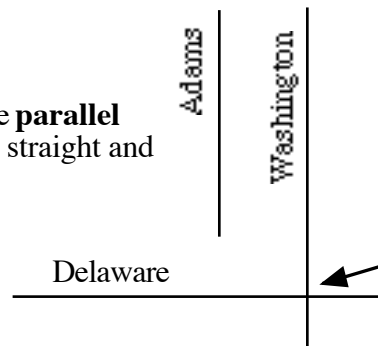
- Solving Formulas (3.1)
- Graphing lines (4.1 and 4.2)
- The slope of a line (4.3)
- The slope-intercept form of a line (4.3)
- The slope formula (4.4)
- Creating the equation of a line (4.5)
- Write an equation from standard form to slope-intercept form (4.6)

INTRODUCTION

On a city street map it is common to find some streets parallel to each other, and others that are perpendicular to each other.

Parallel streets—just like parallel lines—are straight and never intersect; **perpendicular** streets—just like perpendicular lines—meet at right angles to each other.

Adams and Washington are **parallel** to each other; they're both straight and won't intersect.

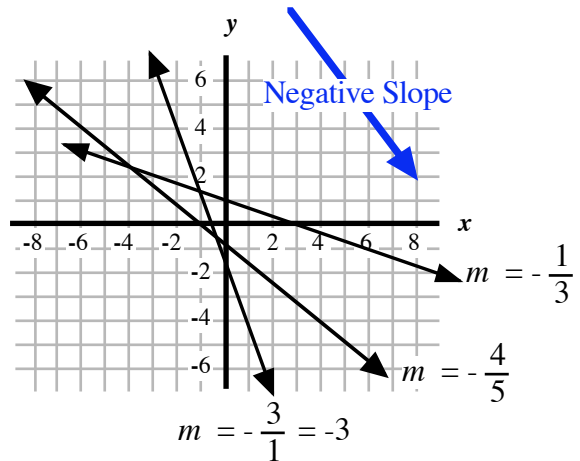
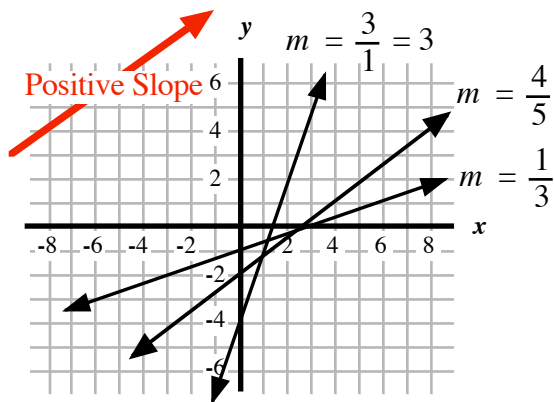


Washington crosses Delaware and they form a right angle, so they are **perpendicular** to each other.

To prepare ourselves for working with parallel and perpendicular lines, let's take another look at the slope of a line.

PROPERTIES OF SLOPES

Lines that slant **up-and-to-the-right** have a **positive** slope, and lines that slant **down-and-to-the-right** have a **negative** slope.



Note: Because a line actually extends in two different directions, we always start at the left and go to the right when consider the slanting to be upward or downward.

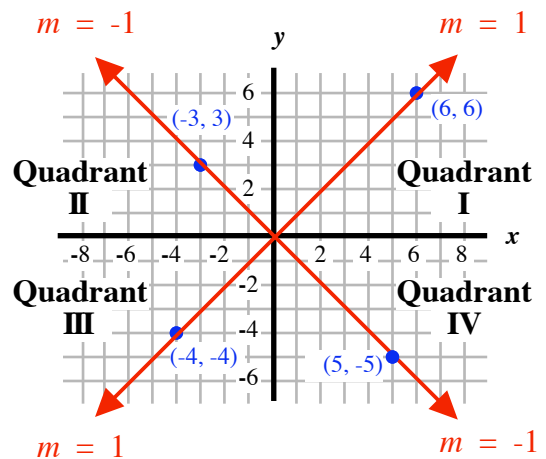
There are two lines that pass through the origin that have the affect of splitting the quadrants in half.

One splits the first and third quadrant in half and has a slope of $m = 1$.

The other splits the second and fourth quadrant in half and has a slope of $m = -1$.

For these slopes, the amount of rise and the amount of run are the same.

These lines act as dividing lines between two other types of slopes, *steep slopes* and *shallow slopes*.

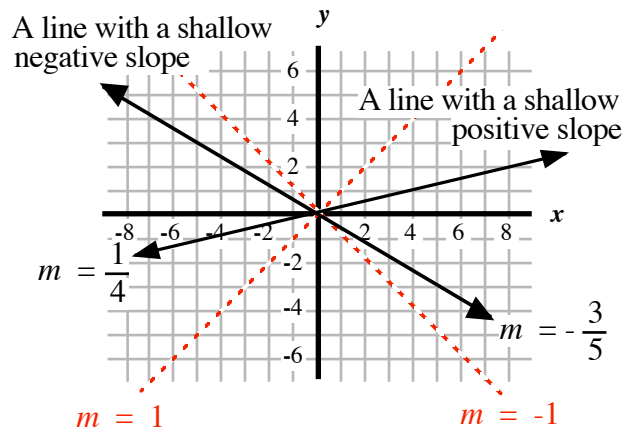


Note: *Steep* and *shallow* slopes are not mathematical terms, but the words help us to describe the degree of slant of the lines on a graph, and that will be helpful throughout this section.

We can consider a line to have a **shallow** slope if the absolute value of a slope of a line is less than 1, $|m| < 1$,

This means that the amount of rise is less than the amount of run. This is true for both positive and negative slopes with value of m

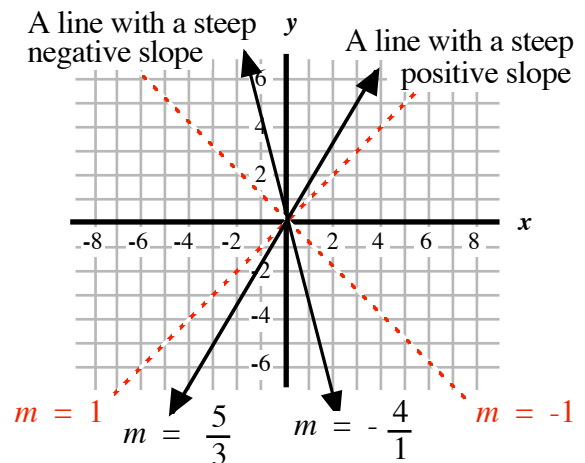
such as $m = \frac{1}{4}$ and $m = -\frac{3}{5}$.



We can consider a line to have a **steep** slope if the absolute value of a slope of a line is more than 1, $|m| > 1$,

This means that the amount of rise is more than the amount of run. This is true for both positive and negative slopes with value of m such as $m =$

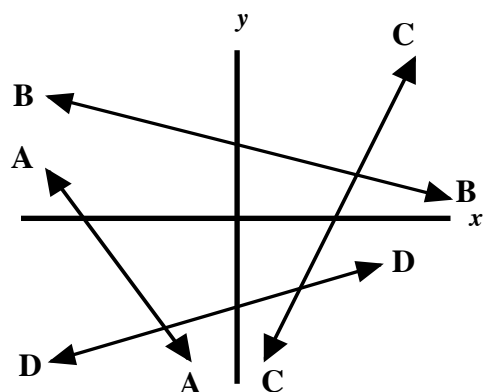
$\frac{5}{3}$ and $m = -\frac{4}{1}$.



YTI 1

Match up the lines in the diagram (A, B, C, or D) with the given slopes.

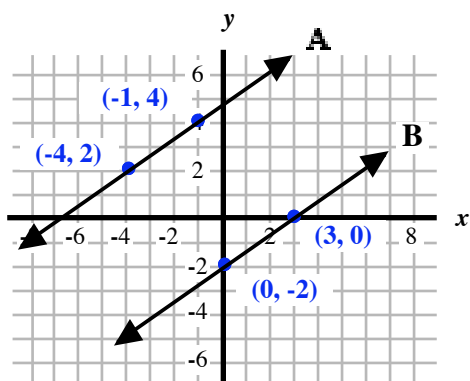
- a) 2
- b) $-\frac{1}{4}$
- c) $\frac{2}{7}$
- d) $-\frac{4}{3}$



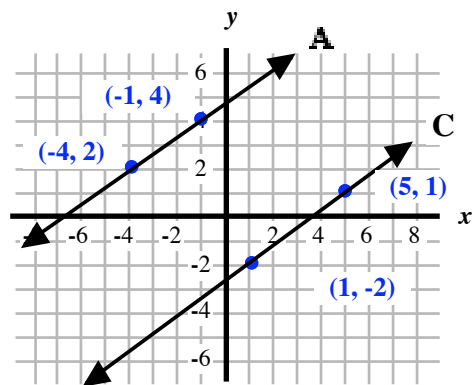
PARALLEL LINES IN THE x - y -PLANE

In the x - y -plane, two lines are parallel if they never intersect (never cross each other). Some lines might look as if they don't cross, but that might be only in the part of the graph that is drawn. Remember, lines go on forever in each direction, so even though they may look like they don't intersect, they still could intersect somewhere off in the distance.

For example, consider these diagrams with lines **A**, **B** and **C**.



Lines A and B are parallel



Lines A and C are NOT parallel

Lines **A** and **C** may look parallel, but they will actually meet at the point $(95, 68)$; that's quite a way into the first quadrant! (The process for finding where two lines intersect is discussed in Chapter 5.)

So what does it take for two lines to be parallel? And, how can we tell that lines **A** and **C** are *not* parallel?

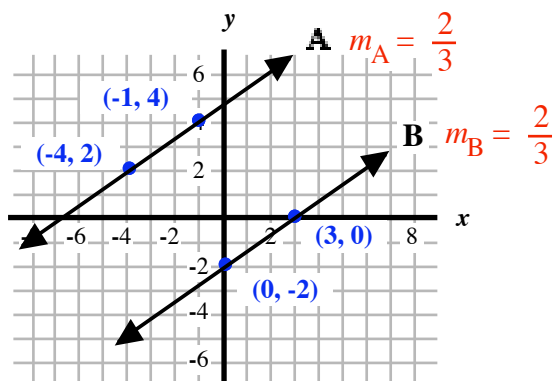
The key is the slope:

Two lines are **parallel** if and only if they have exactly the same slope.

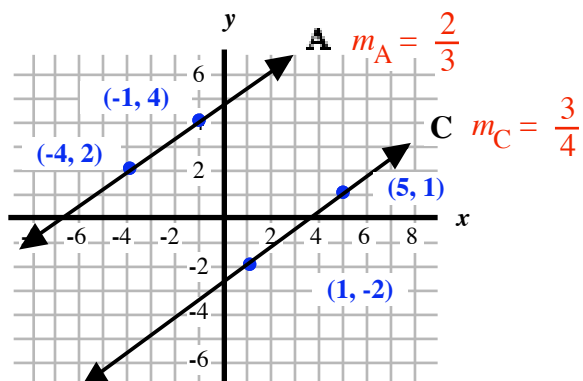
$$m_1 = m_2 \quad \text{or} \quad m_A = m_B$$

Note: We sometimes use subscripts with each m to indicate the slopes of two different lines. Sometimes we use subscripts 1 and 2 and other times A and B .

Here are the comparisons with lines A, B, and C, again, this time with their slopes listed:



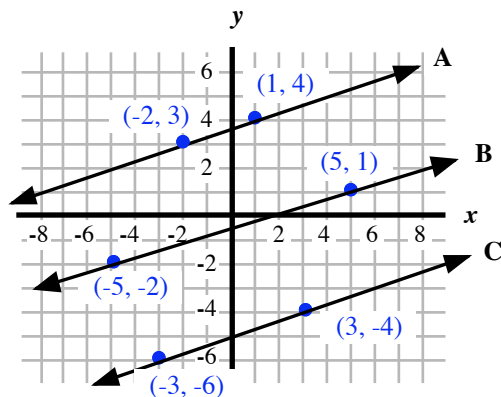
Lines A and B have the same slope: $m_A = m_B$.
These lines are parallel.



Lines A and C have different slopes: $m_A \neq m_C$.
These lines are *not* parallel.

Example 1:

Given the graphs of lines A, B and C, determine which two (or more) are parallel to each other.



Procedure:

Find the slope of each line by either counting the spaces or using the slope formula.

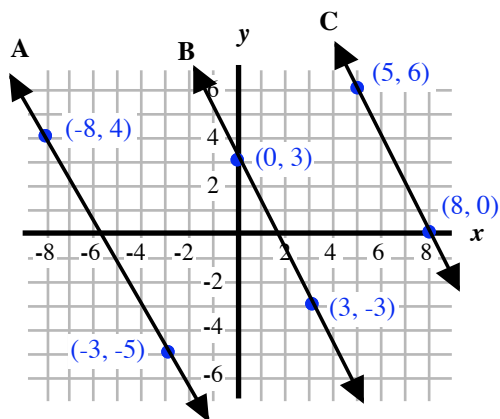
$$m_A = \frac{4 - 3}{1 - (-2)} = \frac{1}{3} ; \quad m_B = \frac{1 - (-2)}{5 - (-5)} = \frac{3}{10} ; \quad m_C = \frac{-4 - (-6)}{3 - (-3)} = \frac{2}{6} = \frac{1}{3} ;$$

Answer:

Lines A and C are parallel to each other.

YTI 2

Given the graphs of lines A, B and C, determine which two (or more) are parallel to each other. Use Example 1 as a guide.



GRAPHING PARALLEL LINES

Given Line A in the x - y -plane, we can draw Line B parallel to Line A, through some given point in the plane. There is one restriction to drawing parallel lines: Lines A and B cannot share any points. This means that the given point cannot be on Line A.

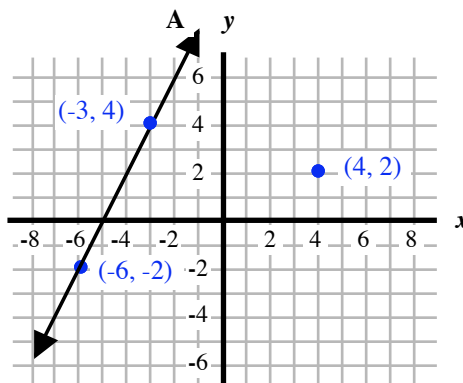
To draw the graph of Line B, we must know the slope of Line A, m_A . The slope of Line B, m_B , is equal to the slope of Line A: $m_B = m_A$.

Example 2: At right is the graph of line A,

$$y = 2x + 10.$$

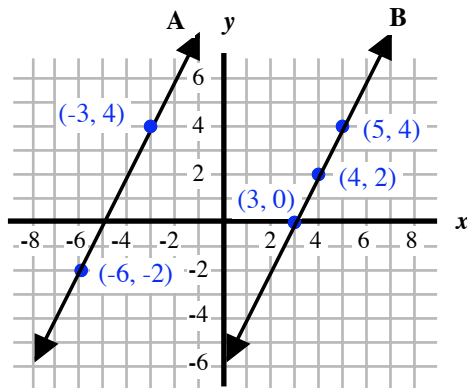
Draw line B parallel to line A, passing through the point $(4, 2)$.

Procedure: From the equation, we see that $m_A = 2$, so the slope of line B is also 2. Use this slope to find two other points on line B and draw line B.



$$m_B = 2 = \frac{2}{1}. \text{ Use } \frac{\text{rise}}{\text{run}} = \frac{2}{1} \text{ or } \frac{-2}{-1} \text{ to find two other points on Line B.}$$

Answer:



Example 3:

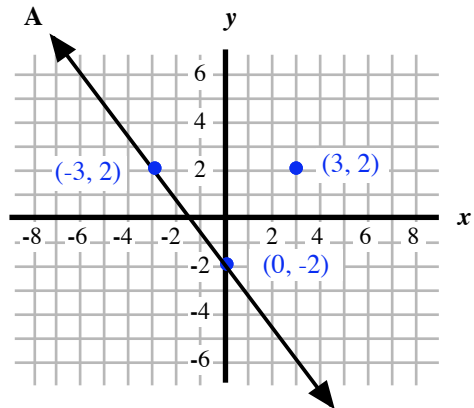
At right is the graph of line A,

$$4x + 3y = -6$$

Draw line B parallel to line A, passing through the point (4, 2).

Procedure:

To find m_A we must first write the equation in slope-intercept form. This means we must solve for y.



$$4x + 3y = -6$$

$$3y = 4x - 6$$

$$\frac{3y}{3} = \frac{4x - 6}{3}$$

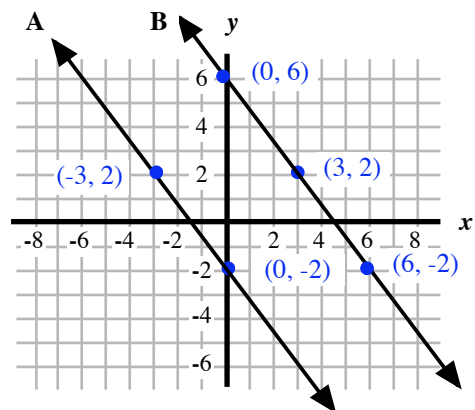
$$y = \frac{4}{3}x - 2$$

$$m_A = \frac{4}{3}$$

$$m_B = \frac{4}{3}$$

We can not plot more points of line B.

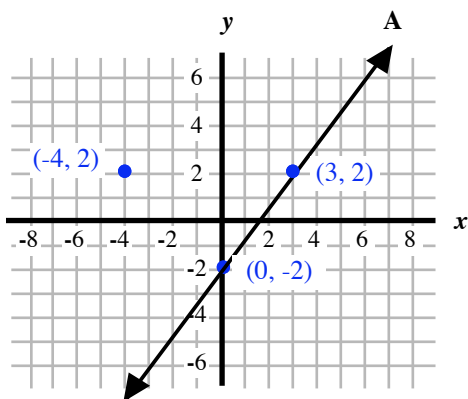
Answer:



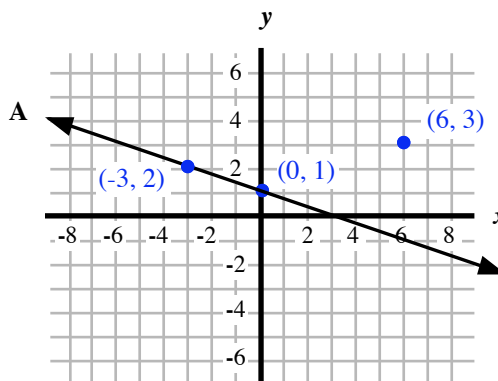
YTI 3

For each, given the graph of Line A, draw Line B parallel to Line A through the given point. Use Examples 2 and 3 as guides.

- a) Line A is $y = \frac{4}{3}x - 2$
Draw Line B through the point $(-4, 2)$.



- b) Line A is $x + 3y = 3$
Draw Line B through the point $(6, 3)$.



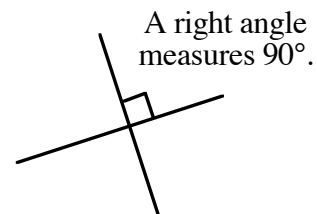
Think about it 1

If Line A has a y-intercept point at $(0, 3)$, and if Line B is parallel to Line A, can Line B also have a y-intercept point at $(0, 3)$? Explain your answer.

PERPENDICULAR LINES

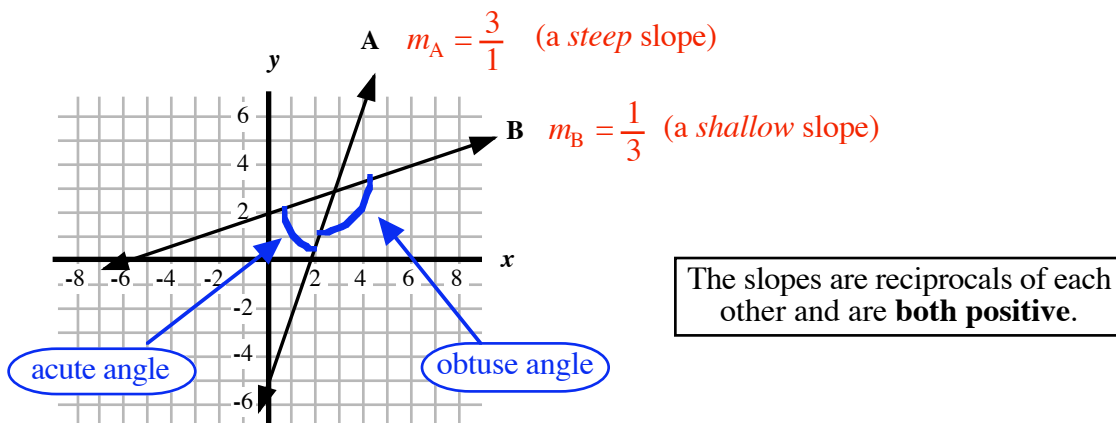
Let's use our understanding of positive and negative slopes and steep and shallow slopes to develop an understanding about perpendicular lines.

As mentioned earlier, perpendicular lines meet at right angles. A right angle measures 90° .

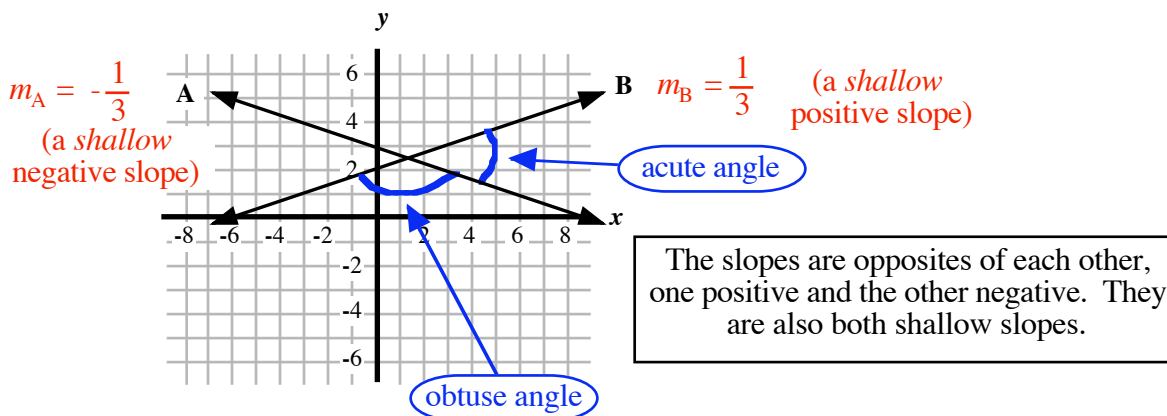


First, here are two lines with *reciprocal* slopes, $m_A = \frac{3}{1}$ and $m_B = \frac{1}{3}$. Both are positive, and one line has a steep slope (m_1) and the other has a shallow slope (m_2). Together, the lines form acute and obtuse angles. These lines are **NOT** perpendicular to each other.

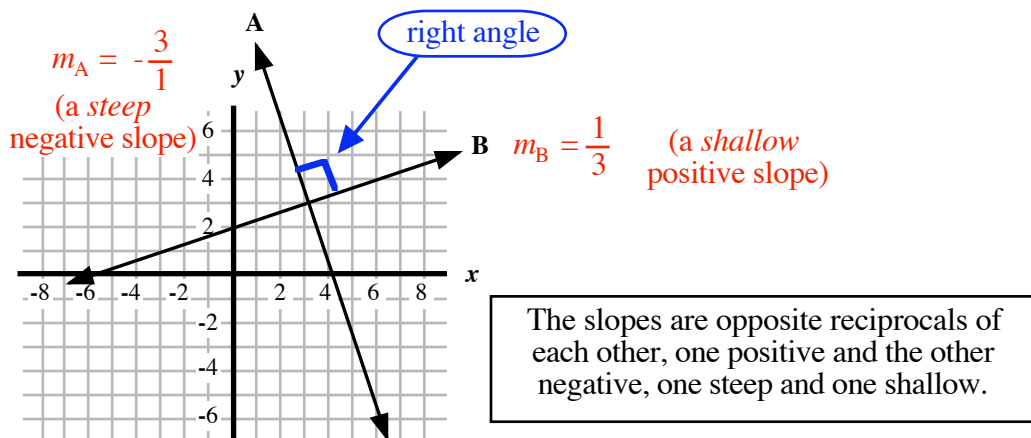
Note: Acute angles measure less than 90° , less than a right angle; obtuse angles measure more than 90° , more than a right angle.



Second, here are two lines with *opposite* slopes, $m_A = -\frac{1}{3}$ and $m_B = \frac{1}{3}$. One slope is positive and the other is negative. Notice, also that these slopes are both shallow and, together, the lines form acute and obtuse angles. These lines are **NOT** perpendicular to each other.



Third, here are two lines with *opposite reciprocal* slopes, $m_A = -\frac{3}{1}$ and $m_B = \frac{1}{3}$. One slope is positive and the other is negative; one is steep and the other is shallow. Together, the lines form right angles. These lines **ARE** perpendicular to each other.



The point of all of this is:

Two lines are perpendicular only if their slopes are **both** OPPOSITE **and** RECIPROCAL of each other.

Two lines are **perpendicular** if and only if their slopes are

1. Opposites and
2. Reciprocals of each other.

This means that their product is -1: $m_A \cdot m_B = -1$.

Example 4: Given the equations of two lines, A and B, determine if they are perpendicular to each other.

a) **A:** $y = \frac{5}{2}x - 3$ b) **A:** $y = -\frac{8}{3}x + 1$ c) **A:** $y = \frac{3}{4}x + 2$

B: $y = \frac{2}{5}x + 6$ **B:** $y = \frac{8}{3}x - 4$ **B:** $y = -\frac{4}{3}x + 5$

Procedure: Each line is in slope-intercept form, so the slope is easy to identify; the y-intercept has nothing to do with perpendicular lines, so we can ignore it for this question.

Answer: a) $m_A = \frac{5}{2}$ and $m_B = \frac{2}{5}$

are **not** perpendicular.

These slopes are *reciprocals*, but they are *not opposite*; furthermore, their product is $\frac{5}{2} \cdot \frac{2}{5} = \frac{10}{10} = +1$, not -1 , so the lines

b) $m_A = -\frac{8}{3}$ and $m_B = \frac{8}{3}$

are **not** perpendicular.

These slopes are *opposite*, but they are *not reciprocal*; furthermore, their product is $-\frac{8}{3} \cdot \frac{8}{3} = -\frac{64}{9} \neq -1$, so the lines

c) $m_A = \frac{3}{4}$ and $m_B = -\frac{4}{3}$

are **perpendicular**.

These slopes are *reciprocals* and *opposite*, and their product is $\frac{3}{4} \cdot -\frac{4}{3} = -\frac{12}{12} = -1$, so the lines

YTI 4

Given the equations of two lines, A and B, determine if they are perpendicular to each other. Use Example 4 as a guide.

a) **A:** $y = -\frac{4}{5}x - 9$

b) **A:** $y = -\frac{2}{3}x + 5$

c) **A:** $y = 4x + 2$

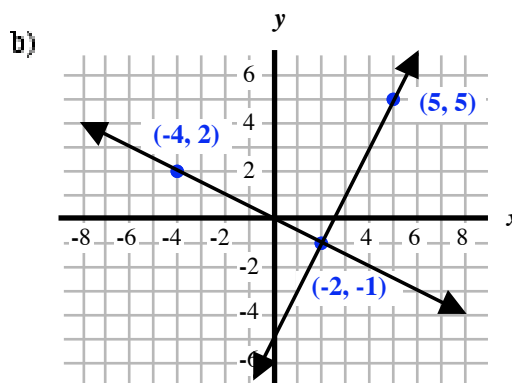
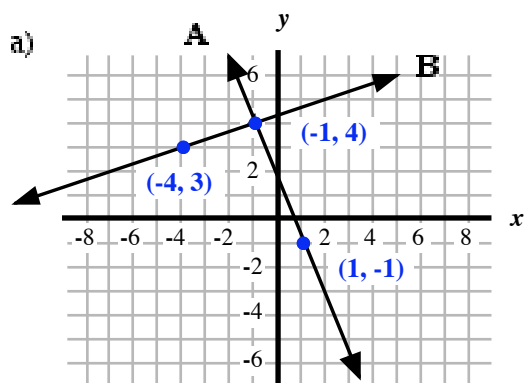
B: $y = \frac{4}{5}x + 9$

B: $y = \frac{3}{2}x + 1$

B: $y = \frac{1}{4}x - 3$

YTI 5

For each pair of lines, A and B, use the slope formula to calculate the slopes and determine if the lines are perpendicular to each other.



Two lines in the same x - y -plane can either intersect or be parallel. If they intersect, they are either perpendicular or not. This means that each pair of lines is either

- (i) parallel; (ii) perpendicular; or (iii) neither of these,

and it all depends on the slope of each line. If a linear equation is in standard form, then writing it in slope-intercept form allows us to easily identify the slope.

Example 5: Given the equations of two lines determine if they are parallel, perpendicular or neither.

$$\mathbf{A:} \quad y = \frac{5}{2}x - 3$$

$$\mathbf{B:} \quad 2x + 5y = 10$$

Procedure: **Line A** is in slope-intercept form, so the slope is easy to identify, $m_A = \frac{5}{2}$.

Line B is in standard form and needs to be rewritten into slope-intercept form. Solve for y to find the slope in equation B.

$$\mathbf{B:} \quad 2x + 5y = 10$$

Move the $2x$ term to the right side where it shows up as $-2x$.

$$5y = -2x + 10$$

Divide each side by 5.

$$\frac{5y}{5} = \frac{-2x + 10}{5}$$

Separate the fraction and simplify.

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

Now we know that $m_B = -\frac{2}{5}$.

So, $m_A = \frac{5}{2}$ and $m_B = -\frac{2}{5}$, are *opposite reciprocals*, and $\frac{5}{2} \cdot -\frac{2}{5} = \frac{-10}{10} = -1$.

Answer: The lines are **perpendicular**.

Example 6: Given the equations of two lines determine if they are parallel, perpendicular or neither. **A:** $6x + 3y = -9$
B: $y = -\frac{1}{2}x + 5$

Procedure: **Line B** is in slope-intercept form, so the slope is easy to identify, $m_B = -\frac{1}{2}$.
Line A is in standard form and needs to be rewritten into slope-intercept form. Solve for y to find the slope in equation A.

A: $6x + 3y = -9$ Move the $6x$ term to the right side where it shows up as $-6x$.

$3y = -6x - 9$ Divide each side by 3.

$\frac{3y}{3} = \frac{-6x - 9}{3}$ Separate the fraction and simplify.

$y = -2x - 3$ Now we know that $m_A = -2$.

So, $m_A = -\frac{1}{2}$ and $m_B = -2$, are reciprocals but not opposites, so the lines are *not* perpendicular; Also, the slopes aren't the same, so the lines are not parallel.

Answer: The lines are **neither** perpendicular nor parallel.

YTI 6 Given the equations of two lines, A and B, determine if they are parallel, perpendicular, or neither. Use Examples 5 and 6 as guides.

- a) **A:** $7x + 3y = -6$ b) **A:** $y = \frac{2}{3}x + 7$ c) **A:** $y = 2x - 9$
B: $y = \frac{7}{3}x + 2$ **B:** $4x - 6y = 12$ **B:** $6x + 3y = 12$

GRAPHING PERPENDICULAR LINES

Just as we can draw parallel lines in the x - y -plane, we can also draw perpendicular lines. Drawing Line B perpendicular to Line A has a process similar to that of drawing a parallel line, with a couple of exceptions:

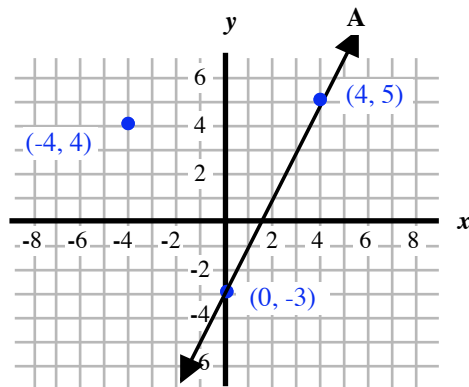
1. the slope of the perpendicular line, m_B , is the opposite reciprocal of the slope of the given line, m_A ; and
2. the perpendicular line can pass through a point on the given line; in other words, the two perpendicular lines will intersect, so they can share a point. (Parallel lines can't share a point.)

Example 7: At right is the graph of Line A,

$$y = 2x - 3$$

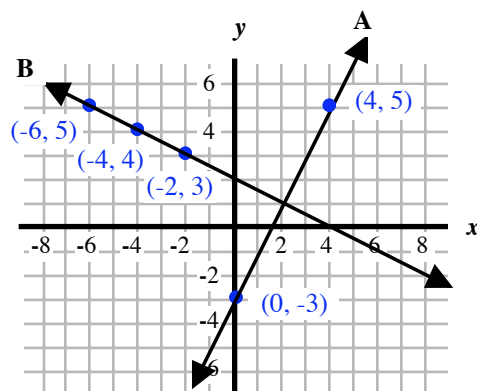
Draw Line B perpendicular to Line A, passing through the point $(-4, 4)$.

Procedure: From the equation, we see that $m_A = 2$, so the slope of line B must be the opposite reciprocal of 2.



$m_B = -\frac{1}{2}$. Use $\frac{\text{rise}}{\text{run}} = \frac{-1}{2}$ or $\frac{1}{-2}$ to find two other points on Line B.

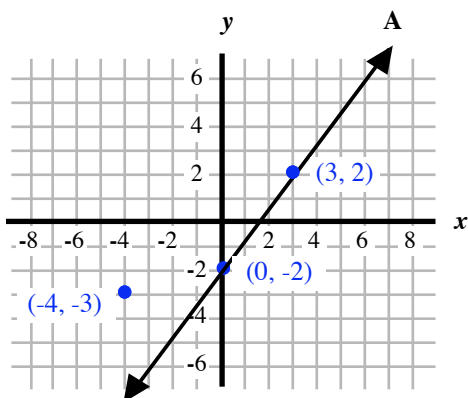
Answer:



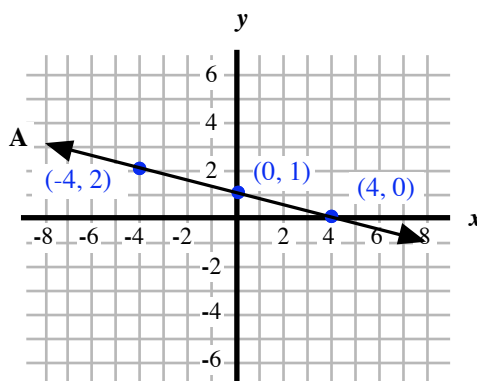
YTI 7

For each, given the graph of Line A, draw Line B perpendicular to Line A through the given point. Use Example 7 as a guide.

- a) Line A is $y = \frac{4}{3}x - 2$
Draw Line B through the point $(-4, -3)$.



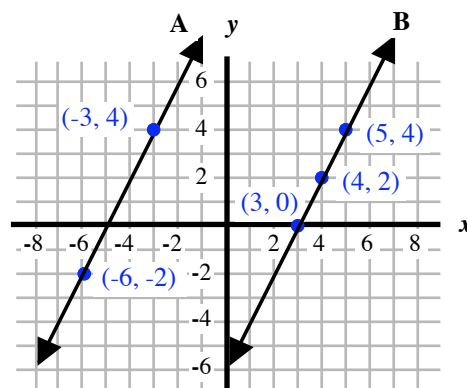
- b) Line A is $y = -\frac{1}{4}x + 1$
Draw Line B through the point $(-4, 2)$.

**EQUATIONS OF PARALLEL AND PERPENDICULAR LINES**

Earlier in this section, in Example 2, we saw Line B graphed parallel to the Line A, $y = 2x + 10$.

Line B passes through a point, $(4, 2)$, which was not on Line A but somewhere else in the x - y -grid.

Question: What is the equation of Line B?



We know, from Section 4.5, that we can find the equation of any line if we know the slope of the line and one point on the line.

In this case, Line B has the same slope as Line A because they are parallel to each other. So, once m_A is identified as 2, we know that $m_B = 2$ as well. Now we can use the known point on Line B, $(4, 2)$, to find its equation:

$$y = mx + b \quad \text{Substitute in } (4, 2) \text{ and } m = 2.$$

$$2 = 2(4) + b \quad \text{Simplify the right side}$$

$$2 - 8 = 8 + b \quad \text{Move 8 to the left side to isolate } b.$$

$$-6 = b$$

So, the equation of Line B is $y = 2x - 6$.

We can find the equations of parallel and perpendicular lines without having a graph. We just need to keep in mind the two things that we need to have in order to write any linear equation:

To write any linear equation, we must have

1. the slope of the line and
2. a point on the line.

Example 8: Write the equation of Line B that passes through $(-10, 3)$ and is parallel to Line A, $y = -\frac{1}{2}x + 4$.

Procedure: In order to find the equation of any line, we must know the slope of the line and one point on the line.

Because Line B is parallel to $y = -\frac{1}{2}x + 4$, $m_B = m_A = -\frac{1}{2}$. Also, we know that Line B passes through $(-10, 3)$, a point on the line.

$$y = mx + b \quad \text{Substitute in } (-10, 3) \text{ and } m = -\frac{1}{2}$$

$$3 = -\frac{1}{2}(-10) + b \quad -\frac{1}{2}(-10) = -\frac{1}{2} \cdot \frac{-10}{1} = +\frac{10}{2} = 5$$

$$3 = 5 + b \quad \text{Move 5 to the other side.}$$

$$3 - 5 = b \quad \text{Simplify.}$$

$$-2 = b$$

Answer: The equation of Line B is $y = -\frac{1}{2}x - 2$

YTI 8

Write the equation of Line B that passes through the given point and is parallel to Line A, Use Example 8 as a guide.

- a) Line A is $y = 4x - 3$
Line B passes through the point $(-2, 6)$.
- b) Line A is $y = -\frac{1}{3}x + 1$
Line B passes through the point $(6, 1)$.

We can also find the equation of perpendicular lines. We must keep in mind that the slope of Line B, m_B , is the opposite reciprocal of the slope of Line A, m_A .

Example 9: Write the equation of Line B that passes through $(-4, 2)$ and is perpendicular to Line A, $y = 2x + 10$.

Procedure: From the equation, $m_A = 2$. Because Line B is *perpendicular* to $y = 2x + 10$, $m_B = -\frac{1}{2}$. We also know a point on Line B, $(-4, 2)$.

$$y = mx + b \quad \text{Substitute in } (-4, 2) \text{ and } m = -\frac{1}{2}$$

$$2 = -\frac{1}{2}(-4) + b \quad -\frac{1}{2} \cdot \frac{-4}{1} = \frac{-4}{-2} = 2$$

$$2 = 2 + b \quad \text{Move 2 from the right side to the left side.}$$

$$2 - 2 = b$$

$$0 = b$$

Answer: The equation of Line B is $y = -\frac{1}{2}x + 0$ or just $y = -\frac{1}{2}x$

YTI 9

Write the equation of Line B that passes through (3, -2) and is perpendicular to Line A, $y = -\frac{1}{3}x - 1$. Use Example 9 as a guide.

Example 10:

Write the equation of the line that passes through (3, 1) and is perpendicular to the line $6x + 4y = 12$.

Procedure:

The problem doesn't state so, but let's refer to $6x + 4y = 12$ as **Line A**, and the perpendicular line (the one we're interested in) as **Line B**.

First, we need to know the slope of Line A and use it to know the slope of Line B. To find m_A , we need to isolate y :

$$6x + 4y = 12$$

Move 6x to the left side.

$$4y = -6x + 12$$

Divide each side by 4.

$$\frac{4y}{4} = \frac{-6x + 12}{4}$$

Separate the fraction.

$$y = \frac{-6x}{4} + \frac{12}{4}$$

Simplify.

$$y = -\frac{3}{2}x + 3$$

$m_A = -\frac{3}{2}$, this means that $m_B = \frac{2}{3}$,

Line B: $y = mx + b$

Substitute in (3, 1) and $m = \frac{2}{3}$

$$1 = \frac{2}{3}(3) + b$$

$$\frac{2}{3}(3) = \frac{2}{3} \cdot \frac{3}{1} = \frac{6}{3} = 2$$

$$1 = 2 + b$$

Move 2 to the left side.

$$1 - 2 = b$$

$$-1 = b$$

Answer:

The equation of Line B is $y = \frac{2}{3}x - 1$

Example 11:

Write the equation of Line B that passes through (-10, -6) and is parallel to Line A, $y = -\frac{2}{5}x - 3$.

Procedure:

$$m_A = -\frac{2}{5} \quad \text{so, } m_B = -\frac{2}{5} \quad \text{also.}$$

$$\text{Line B: } y = mx + b \quad \text{Substitute in } (-10, -6) \text{ and } m = -\frac{2}{5}$$

$$-6 = -\frac{2}{5}(-10) + b \quad -\frac{2}{5}(-10) = -\frac{2}{5} \cdot \frac{10}{1} = \frac{20}{5} = 4$$

$$-6 = 4 + b \quad \text{Move 4 to the left side.}$$

$$-6 - 4 = b$$

$$-10 = b$$

Answer:

The equation of Line B is $y = -\frac{2}{5}x - 10$

YTI 10

Find the equation of the line that passes through (-2, 9) and is

a) parallel to $5x + y = 4$

b) perpendicular to $y = -2x - 7$

YTI 11

Find the equation of the line that passes through (-6, 1) and is

a) parallel to $y = \frac{4}{3}x - 6$

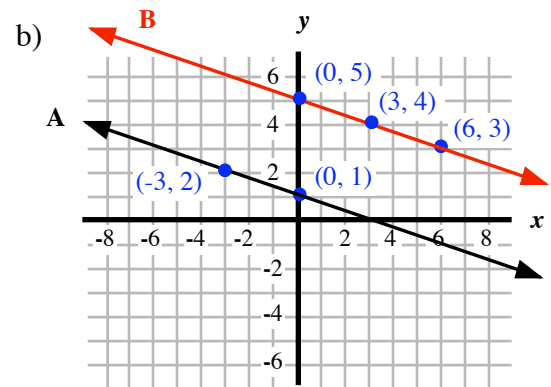
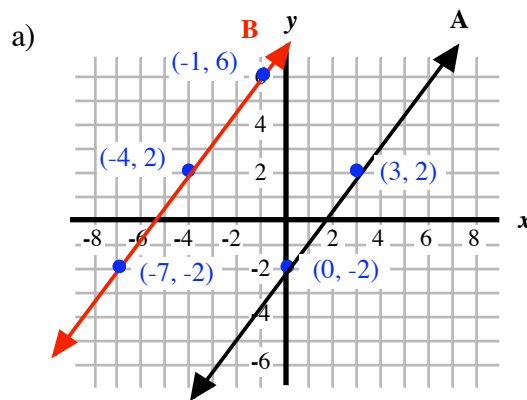
b) perpendicular to $3x + 2y = 5$

Answers: You Try It and Think About It

YTI 1: a) C b) B c) D d) A

YTI 2: $m_A = -\frac{9}{11}$; $m_B = -2$; $m_C = -2$, so Lines B and C are parallel.

YTI 3:



YTI 4: a) $m_A = -\frac{4}{5}$; $m_B = \frac{4}{5}$ NOT perpendicular; (these are opposite but not reciprocal.)

b) $m_A = -\frac{2}{3}$; $m_B = \frac{3}{2}$ ARE perpendicular; (these are opposite reciprocals.)

c) $m_A = 4$; $m_B = \frac{1}{4}$ NOT perpendicular; (these are reciprocal but not opposite.)

YTI 5: a) $m_A = \frac{1}{3}$; $m_B = -\frac{5}{2}$ NOT perpendicular

b) $m_A = -\frac{1}{2}$; $m_B = 2$ ARE perpendicular

YTI 6: a) $m_A = -\frac{7}{3}$; $m_B = \frac{7}{3}$ The lines are neither perpendicular nor parallel.

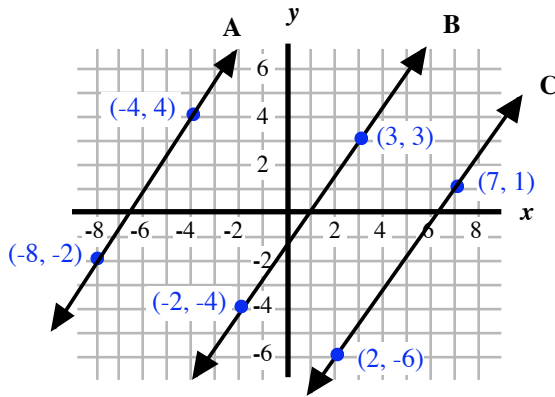
b) $m_A = \frac{2}{3}$; $m_B = \frac{2}{3}$ The lines are parallel.

b) $m_A = 2$; $m_B = -2$ The lines are neither perpendicular nor parallel.

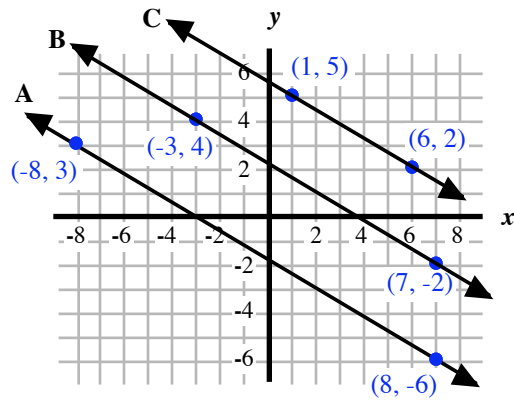
Focus Exercises.

Given the graphs of lines A, B and C, determine which two (or more) are parallel to each other.

5.



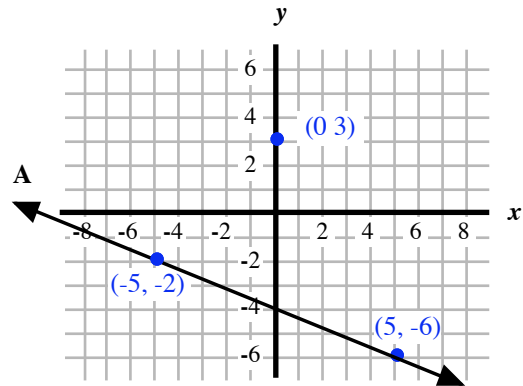
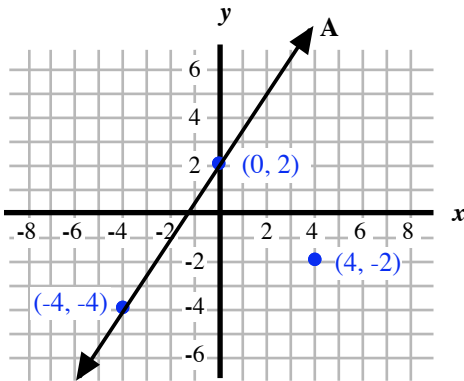
6.



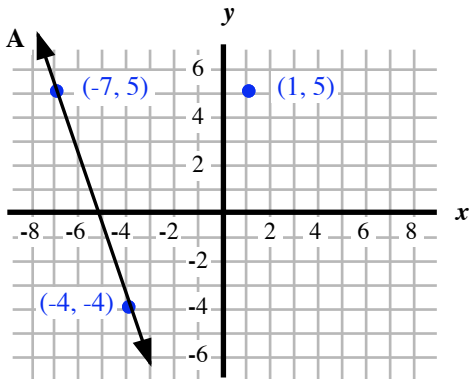
For each, given the graph of Line A, draw Line B parallel to Line A through the given point.

7. Line A is $y = \frac{3}{2}x + 2$
Draw Line B through the point $(4, -2)$.

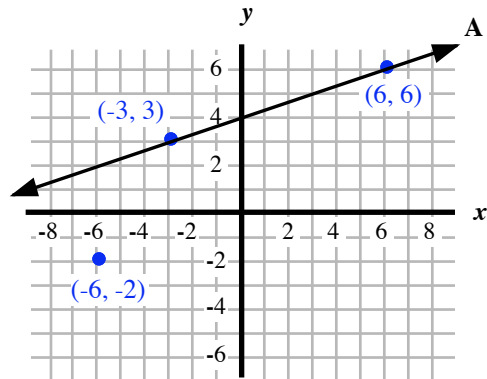
8. Line A is $2x + 5y = -20$
Draw Line B through the point $(0, 3)$.



9. Line A is $y = -3x - 16$
Draw Line B through the point $(1, 5)$.

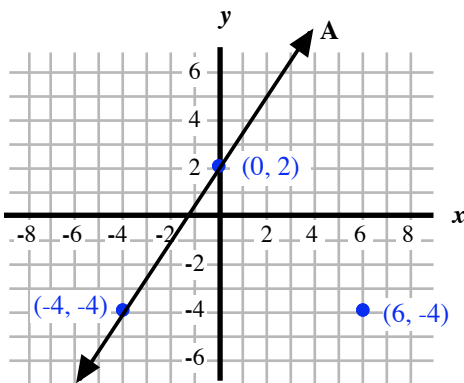


10. Line A is $x - 3y = -12$
Draw Line B through the point $(-6, -2)$.

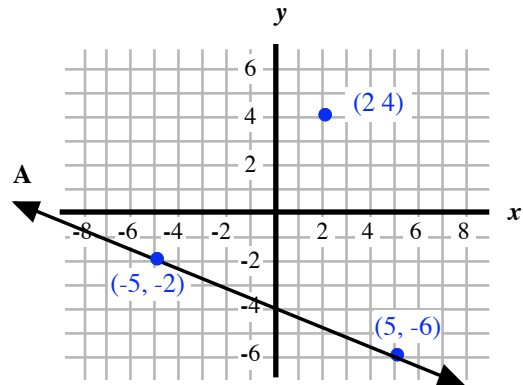


For each, given the graph of Line A, draw Line B perpendicular to Line A through the given point.

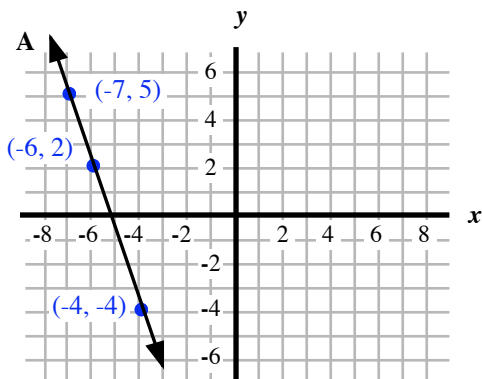
11. Line A is $y = \frac{3}{2}x + 2$
Draw Line B through the point $(6, -4)$.



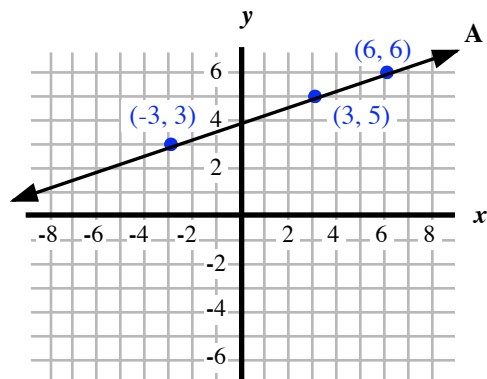
12. Line A is $2x + 5y = -20$
Draw Line B through the point $(2, 4)$.



13. Line A is $y = -3x - 16$
Draw Line B through the point $(-6, 2)$.



14. Line A is $x - 3y = -12$
Draw Line B through the point $(3, 5)$.



Given the equations of two lines, A and B, determine if they are parallel, perpendicular, or neither.

15. **A:** $y = \frac{4}{6}x - 6$

B: $y = \frac{2}{3}x + 5$

16. **A:** $y = -\frac{2}{3}x - 9$

B: $y = -\frac{8}{12}x + 3$

17. **A:** $y = -\frac{8}{4}x - 7$

B: $y = \frac{6}{3}x + 11$

18. **A:** $y = \frac{6}{8}x + 5$

B: $y = -\frac{9}{12}x + 1$

19. **A:** $y = \frac{4}{6}x - 2$

B: $y = -\frac{3}{2}x + 9$

20. **A:** $y = -\frac{2}{5}x + 8$

B: $y = \frac{10}{4}x - 6$

21. **A:** $y = 3x - 5$

B: $6x + 2y = 8$

22. **A:** $6x + 3y = 9$

B: $y = -2x - 4$

23. **A:** $y = \frac{1}{4}x - 2$

B: $x - 4y = 12$

24. **A:** $3x - 5y = 10$

B: $y = \frac{3}{5}x + 1$

25. **A:** $y = -\frac{4}{3}x - 6$

B: $3x - 4y = -8$

26. **A:** $y = \frac{1}{2}x + 3$

B: $10x - 5y = 2$

Find the equation of Line B as described.

27. Line B passes through (2, 5) and is parallel to $y = 4x + 6$

28. Line B passes through (3, 8) and is parallel to $y = 2x - 4$

29. Line B passes through (-2, 9) and is parallel to $y = 3x - 5$

30. Line B passes through (-1, -7) and is parallel to $y = -2x + 1$

31. Line B passes through (8, -2) and is parallel to $y = \frac{3}{4}x + 7$

32. Line B passes through (-6, -1) and is parallel to $y = -\frac{5}{2}x - 2$

33. Line B passes through (8, -5) and is perpendicular to $y = 4x + 3$

34. Line B passes through (-4, 1) and is perpendicular to $y = 2x - 4$

35. Line B passes through (10, -2) and is perpendicular to $y = 5x - 4$
36. Line B passes through (9, 2) and is perpendicular to $y = -3x + 1$
37. Line B passes through (-6, 5) and is perpendicular to $y = \frac{3}{4}x + 7$
38. Line B passes through (-10, -3) and is perpendicular to $y = -\frac{5}{2}x - 2$
39. Line B passes through (4, -3) and is parallel to $y = x + 6$
40. Line B passes through (-1, -7) and is parallel to $y = -x - 4$
41. Line B passes through (4, -3) and is perpendicular to $y = -x + 7$
42. Line B passes through (-1, -7) and is perpendicular to $y = x - 8$
43. Line B passes through (7, 4) and is parallel to $6x - 2y = 8$
44. Line B passes through (-6, -1) and is parallel to $8x + 4y = -12$
45. Line B passes through (5, -1) and is perpendicular to $x - 3y = 6$
46. Line B passes through (3, -5) and is perpendicular to $2x + 4y = 4$
47. Line B passes through (-6, 2) and is perpendicular to $5x + 3y = -12$
48. Line B passes through (-9, 4) and is perpendicular to $3x - 4y = -8$
49. Line B passes through (8, 5) and is parallel to $7x - 2y = -6$
50. Line B passes through (15, 7) and is parallel to $2x + 5y = -10$

Think Outside the Box.

51. Line A is given by $y = \frac{2}{3}x - 5$. Line B passes through the point (-4, 4) and is perpendicular to Line A. Line C passes through the point (3, 4) and is perpendicular to Line B. What is the equation of Line C? (Hint: it isn't necessary to find the equation of Line B, but it is helpful to draw all three lines.)
52. A right triangle has one pair of sides that forms a right angle; that is, the sides are perpendicular to each other. If the points (-8, 1), (-4, -5), and (8, 3) are connected together by line segments, they form a triangle. Do they form a *right* triangle?