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4.3 Writing Equations of Parallel and Perpendicular Lines

For use with Exploration 4.3

Essential Question How can you recognize lines that are parallel or perpendicular?

1 EXPLORATION: Recognizing Parallel Lines

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Write each linear equation in slope-intercept form. Then use a graphing calculator to graph the three equations in the same square viewing window. (The graph of the first equation is shown.) Which two lines appear parallel? How can you tell?

a. $3x + 4y = 6$

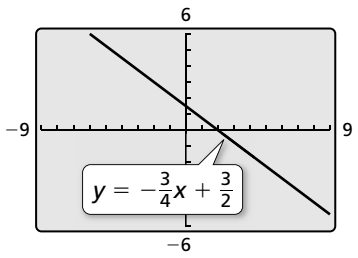
$3x + 4y = 12$

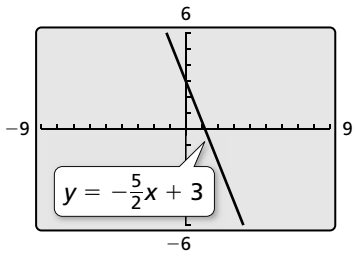
$4x + 3y = 12$

b. $5x + 2y = 6$

$2x + y = 3$

$2.5x + y = 5$





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2 EXPLORATION: Recognizing Perpendicular Lines

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Write each linear equation in slope-intercept form. Then use a graphing calculator to graph the three equations in the same square viewing window. (The graph of the first equation is shown.) Which two lines appear perpendicular? How can you tell?

a. $3x + 4y = 6$

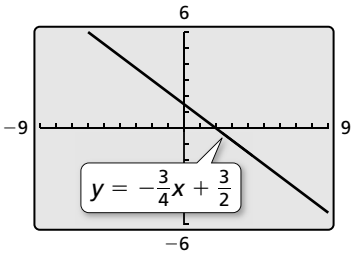
$3x - 4y = 12$

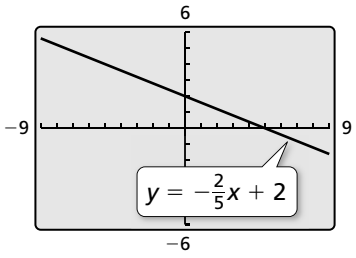
$4x - 3y = 12$

b. $2x + 5y = 10$

$-2x + y = 3$

$2.5x - y = 5$





Communicate Your Answer

3. How can you recognize lines that are parallel or perpendicular?

4. Compare the slopes of the lines in Exploration 1. How can you use slope to determine whether two lines are parallel? Explain your reasoning.

5. Compare the slopes of the lines in Exploration 2. How can you use slope to determine whether two lines are perpendicular? Explain your reasoning.

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4.3 Practice
For use after Lesson 4.3

Core Concepts

Parallel Lines and Slopes

Two lines in the same plane that never intersect are **parallel lines**. Two distinct nonvertical lines are parallel if and only if they have the same slope.

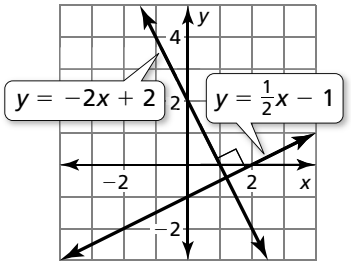
All vertical lines are parallel.

Notes:

Perpendicular Lines and Slopes

Two lines in the same plane that intersect to form right angles are **perpendicular lines**. Nonvertical lines are perpendicular if and only if their slopes are negative reciprocals.

Vertical lines are perpendicular to horizontal lines.



Notes:

Worked-Out Examples

Example #1

Write an equation of the line that passes through the given point and is parallel to the given line.

(18, 2); $3y - x = -12$

$$3y - x = -12$$
$$3y - x + x = -12 + x$$
$$3y = -12 + x$$
$$\frac{3y}{3} = \frac{-12 + x}{3}$$
$$y = -4 + \frac{1}{3}x, \text{ or } y = \frac{1}{3}x - 4$$
$$y = mx + b$$
$$2 = \frac{1}{3}(18) + b$$
$$2 = 6 + b$$
$$\underline{-6} \quad \underline{-6}$$
$$-4 = b$$

Using $m = \frac{1}{3}$ and $b = -4$, an equation of the parallel line is $y = \frac{1}{3}x - 4$.

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4.3 Practice (continued)

Example #2

Write an equation of the line that passes through the given point and is perpendicular to the given line.

$(7, 10)$; $y = \frac{1}{2}x - 9$

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

$y - 10 = -2(x - 7)$

$y - 10 = -2(x) - 2(-7)$

$y - 10 = -2x + 14$

$+ 10 \qquad + 10$

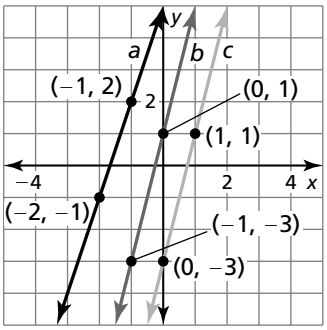
$y = -2x + 24$

An equation of the perpendicular line is $y = -2x + 24$.

Practice A

In Exercises 1–6, determine which of the lines, if any, are parallel. Explain.

1.



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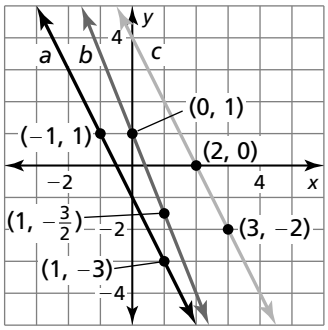

3. Line a passes through $(-4, -1)$ and $(2, 2)$.
Line b passes through $(-5, -3)$ and $(5, 1)$.
Line c passes through $(-2, -3)$ and $(2, -1)$.

4. Line a passes through $(-2, 5)$ and $(2, 1)$.
Line b passes through $(-4, 3)$ and $(3, 4)$.
Line c passes through $(-3, 4)$ and $(2, -6)$.

5. Line a: $4x = -3y + 9$
Line b: $8y = -6x + 16$
Line c: $4y = -3x + 9$

6. Line a: $5y - x = 4$
Line b: $5y = x + 7$
Line c: $5y - 2x = 5$

In Exercises 7 and 8, write an equation of the line that passes through the given point and is parallel to the given line.

7. $(3, -1)$; $y = \frac{1}{3}x - 3$

8. $(1, -2)$; $y = -2x + 1$

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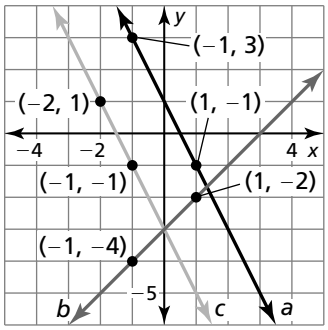
4.3 Practice (continued)

In Exercises 9–14, determine which of the lines, if any, are parallel or perpendicular. Explain.

9.



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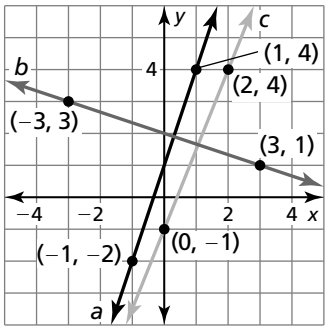

11. Line a passes through $(-2, 4)$ and $(1, 1)$.
Line b passes through $(2, 1)$ and $(4, 4)$.
Line c passes through $(1, -2)$ and $(-1, 4)$.

12. Line a passes through $(-2, -4)$ and $(-1, -1)$.
Line b passes through $(-1, -4)$ and $(1, 2)$.
Line c passes through $(2, 3)$ and $(4, 2)$.

13. Line a: $y = \frac{3}{4}x + 1$
Line b: $-3y = 4x - 3$
Line c: $4y = -3x + 9$

14. Line a: $5y - 2x = 1$
Line b: $y = \frac{5}{2}x - 1$
Line c: $y = \frac{2}{5}x + 3$

In Exercises 15 and 16, write an equation of the line that passes through the given point and is perpendicular to the given line.

15. $(-2, 2)$; $y = \frac{2}{3}x + 2$

16. $(3, 1)$; $2y = 4x - 3$

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Practice B

In Exercises 1 and 2, determine which of the lines, if any, are parallel. Explain.

1. Line a passes through $(-1, 4)$ and $(1, 5)$.
Line b passes through $(-2, 7)$ and $(0, 4)$.
Line c passes through $(0, 4)$ and $(2, 5)$.

2. Line a: $6y = -x + 12$
Line b: $x = 6y + 5$
Line c: $-6y + x = 5$

In Exercises 3 and 4, write an equation of the line that passes through the given point and is parallel to the given line.

3. $(14, 3)$; $2y - x = 8$

4. $(3, -5)$; $3y = 2x - 1$

In Exercises 5 and 6, determine which of the lines, if any, are parallel or perpendicular. Explain.

5. Line a passes through $(-5, -2)$ and $(1, -1)$.
Line b passes through $(-3, 5)$ and $(3, 6)$.
Line c passes through $(0, 7)$ and $(1, 1)$.

6. Line a: $-x + 2y = 3$
Line b: $-6x = 3y - 1$
Line c: $4x - 8y = 5$

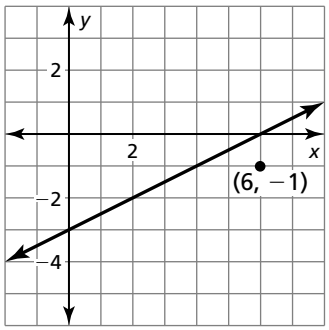
In Exercises 7 and 8, write an equation of the line that passes through the given point and is perpendicular to the given line.

7. $(-3, 1)$; $y = -5x + 2$

8. $(8, -5)$; $y = 2x + 3$

In Exercises 9 and 10, write an equation of the line that passes through the given point and is (a) parallel and (b) perpendicular to the given line.

9.



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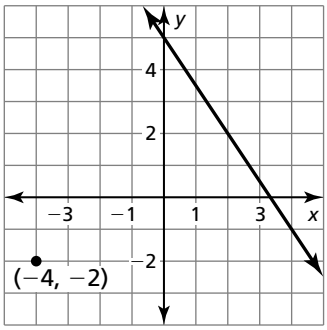

In Exercises 11–13, determine whether the statement is *sometimes*, *always*, or *never* true. Explain your reasoning.

11. A line with a positive slope and a line with a negative slope are perpendicular.

12. A vertical line and a horizontal line are perpendicular.

13. Two horizontal lines are perpendicular.