

## 4.3 Start Thinking

Use your knowledge of slope to explain how you can determine if two lines are parallel by looking at their graphs.

Graph the lines  $y = 5x$  and  $y = -5x$ . Do the lines make  $90^\circ$  angles at the point of intersection? Does this prove or disprove the idea that perpendicular lines have opposite slopes?

## 4.3 Warm Up

Write an equation in point-slope form of the line that passes through the given point and has the given slope.

1.  $(-5, -7)$ ;  $m = -3$
2.  $(9, -3)$ ;  $m = \frac{8}{3}$
3.  $(0, -1)$ ;  $m = 3$
4.  $(2, 0)$ ;  $m = -1$
5.  $(-4, 2)$ ;  $m = -\frac{4}{7}$
6.  $(-5, -3)$ ;  $m = \frac{1}{2}$

## 4.3 Cumulative Review Warm Up

Write the sentence as an inequality. Graph the inequality.

1. A number  $q$  is greater than 7 or less than 1.
2. A number  $p$  is greater than or equal to  $-6$  and less than 11.
3. A number  $n$  is less than  $-6\frac{1}{4}$  and at least  $-11$ .
4. A number  $s$  is no more than  $-0.4$  or greater than 10.4.

**4.3****Practice A**

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

- |   |                          |
|---|--------------------------|
| 1. Line $a$ passes through $(-1, 1)$ and $(1, 3)$ . | 2. Line $a: 2y = x + 12$ |
| Line $b$ passes through $(3, 4)$ and $(0, 2)$ .     | Line $b: 2y - x = 5$     |
| Line $c$ passes through $(0, 1)$ and $(3, 3)$ .     | Line $c: 2y + x = 4$     |

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

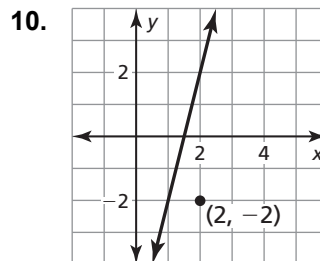
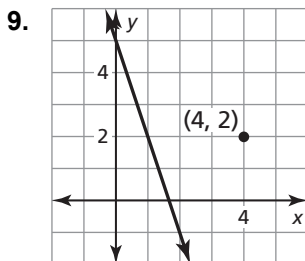
In Exercises 5 and 6, determine which of the lines, if any, are parallel or perpendicular. Explain.

- |  |                          |
|--|--------------------------|
| 5. Line $a$ passes through $(-2, 3)$ and $(1, -1)$ . | 6. Line $a: y = -4x + 7$ |
| Line $b$ passes through $(-3, 1)$ and $(1, 4)$ .     | Line $b: x = 4y + 2$     |
| Line $c$ passes through $(0, 2)$ and $(3, -2)$ .     | Line $c: -4y + x = 3$    |

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. $(2, -3); y = \frac{1}{3}x - 5$ | 8. $(6, 1); y = -\frac{3}{5}x - 5$ |
|------------------------------------|------------------------------------|

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.



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

- A line with a positive slope and a line with a negative slope are parallel.
- A vertical line is perpendicular to the  $x$ -axis.
- Two lines with the same  $x$ -intercept are perpendicular.

## 4.3 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 $(1, 5)$ . | 2. Line $a: 6y = -x + 12$ |
| Line $b$ passes through $(-2, 7)$ and $(0, 4)$ .    | Line $b: x = 6y + 5$      |
| Line $c$ passes through $(0, 4)$ and $(2, 5)$ .     | 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.

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|--------------------------|---------------------------|
| 3. $(14, 3); 2y - x = 8$ | 4. $(3, -5); 3y = 2x - 1$ |
|--------------------------|---------------------------|

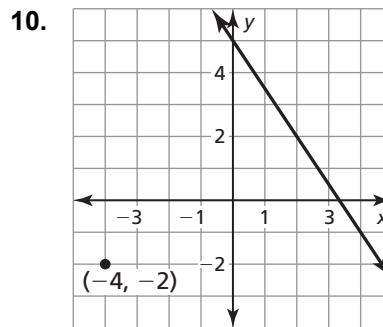
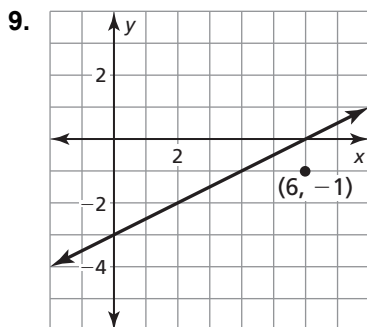
In Exercises 5 and 6, determine which of the lines, if any, are parallel or perpendicular. Explain.

- |   |                          |
|---|--------------------------|
| 5. Line $a$ passes through $(-5, -2)$ and $(1, -1)$ . | 6. Line $a: -x + 2y = 3$ |
| Line $b$ passes through $(-3, 5)$ and $(3, 6)$ .      | Line $b: -6x = 3y - 1$   |
| Line $c$ passes through $(0, 7)$ and $(1, 1)$ .       | 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.



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

- A line with a positive slope and a line with a negative slope are perpendicular.
- A vertical line and a horizontal line are perpendicular.
- Two horizontal lines are perpendicular.

## 4.3 Enrichment and Extension

### Coordinate Geometry Proofs

Recall that two lines are parallel if their slopes are equal, and two lines are perpendicular if their slopes are negative reciprocals. In geometry, we can prove that four-sided figures are certain quadrilaterals by using the following formulas and rules for each specific quadrilateral.

Distance Formula:  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$       Midpoint Formula:  $\left(\frac{(x_1 + x_2)}{2}, \frac{(y_1 + y_2)}{2}\right)$

Slope Formula:  $m = \frac{y_2 - y_1}{x_2 - x_1}$

#### Coordinate Proof Methods:

Quadrilateral	Prove the following	Formulas needed
Parallelogram	Show that each pair of opposite sides are parallel.	Slope Formula
Rectangle	1. Show that opposite sides are parallel. 2. Show that adjacent sides are perpendicular.	Slope Formula
Rhombus	Show that all sides are congruent.	Distance Formula
Square	1. Show that the figure is a parallelogram. 2. Show the figure is a rhombus.	Slope Formula Distance Formula
Trapezoid	1. Show that one pair of opposite sides is parallel. 2. Show that the other pair of sides is not parallel.	Slope Formula

In Exercises 1–4, graph the quadrilateral and prove it is either a *parallelogram*, *rectangle*, *rhombus*, *square*, or *trapezoid*.

- $J(-2, 3), K(4, 2), L(6, -4), M(0, -3)$
- $A(-2, 0), B(6, 2), C(9, -2), D(-3, -5)$
- $W(-6, -3), X(-4, 3), Y(2, 1), Z(0, -5)$
- $D(-3, 3), E(0, 3), F(0, -2), G(-3, -2)$



## Puzzle Time

### What Do Snowmen Wear On Their Heads?

Write the letter of each answer in the box containing the exercise number.

**Determine whether the lines are parallel, perpendicular, or neither.**

- Line  $a$  passes through  $(-2, -5)$  and  $(0, -1)$ ; Line  $b$  passes through  $(3, 1)$  and  $(1, -3)$ .
  - parallel
  - perpendicular
  - neither
- Line  $a$  passes through  $(1, 4)$  and  $(3, 6)$ ; Line  $b$  passes through  $(-3, -6)$  and  $(-1, -3)$ .
  - parallel
  - perpendicular
  - neither
- Line  $a$  passes through  $(-4, 5)$  and  $(-2, 8)$ ; Line  $b$  passes through  $(-6, 7)$  and  $(-3, 5)$ .
  - parallel
  - perpendicular
  - neither
- line  $a$ :  $5y - 2x = 9$ ; line  $b$ :  $2y + 5x = -6$ 
  - parallel
  - perpendicular
  - neither
- line  $a$ :  $4y = 8x + 12$ ; line  $b$ :  $6y - 12x = 24$ 
  - parallel
  - perpendicular
  - neither
- Write an equation of the line that passes through  $(-4, -6)$  and is parallel to  $y = 3x - 8$ .
  - $y = 3x - 18$
  - $y = 3x - 6$
  - $y = 3x + 6$
- Write an equation of the line that passes through  $(2, 5)$  and is perpendicular to  $y = \frac{1}{4}x - 12$ .
  - $y = -4x + 3$
  - $y = -4x + 13$
  - $y = -4x - 13$

5	2	4		6	1	7	3
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