3-7

1. Plan

Objectives

1 To relate slope and parallel lines
2 To relate slope and perpendicular lines

Examples

1 Checking for Parallel Lines
2 Determining Whether Lines are Parallel
3 Writing Equations of Parallel Lines
4 Checking for Perpendicular Lines
5 Writing Equations for Perpendicular Lines
6 Real-World Connection

Professional Development

Math Background

Slope is a fixed ratio that characterizes any nonvertical line. It is another example of a pure geometric concept, a line, described by algebraic methods. The product of the slopes of perpendicular lines being -1, although initially surprising, is merely the Pythagorean Theorem in an analytic geometry setting.

More Math Background: p. 124D

Lesson Planning and Resources

See p. 124E for a list of the resources that support this lesson.

PowerPoint

Bell Ringer Practice

Check Skills You'll Need
For intervention, direct students to:

Slope
Algebra 1 Review, page 165

Graphing Lines
Lesson 3-6: Example 3
Extra Skills, Word Problems, Proof Practice, Ch. 3

3-7 Slopes of Parallel and Perpendicular Lines

ALGEBRA

What You'll Learn

- To relate slope and parallel lines
- To relate slope and perpendicular lines

. . . And Why

To write an equation that models part of a leaded glass window, as in Example 6

Check Skills You'll Need

GO for Help page 165 and Lesson 3-6

Find the slope of the line through each pair of points.

1. $F(2, 5), B(-2, 3)$ $\frac{1}{2}$ **2.** $H(0, -5), D(2, 0)$ $\frac{5}{2}$ **3.** $E(1, 1), F(2, -4)$ -5

Find the slope of each line.

4. $y = 2x - 5$ 2 **5.** $x + y = 20$ -1 **6.** $2x - 3y = 6$ $\frac{2}{3}$

7. $x = y$ 1 **8.** $y = 7$ 0 **9.** $y = \frac{2}{3}x + 7$ $\frac{2}{3}$

1 Slope and Parallel Lines

The relationship between slope and parallel lines is summarized below and proved in Lesson 7-3.

Key Concepts

Summary **Slopes of Parallel Lines**

If two nonvertical lines are parallel, their slopes are equal.

If the slopes of two distinct nonvertical lines are equal, the lines are parallel.

Any two vertical lines are parallel.

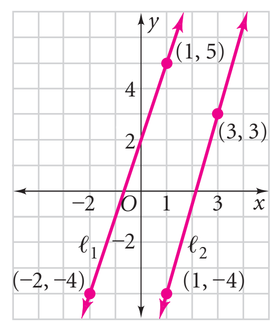
Real-World Connection

The ramp and rails are parallel because they have the same slope.

You can test whether nonvertical lines are parallel by comparing their slopes.

1 EXAMPLE Checking for Parallel Lines

Are lines ℓ_1 and ℓ_2 parallel? Explain.



Find and compare the slopes of the lines.

$$\text{slope of } \ell_1 = \frac{5 - (-4)}{1 - (-2)} = \frac{9}{3} = 3$$

$$\text{slope of } \ell_2 = \frac{3 - (-4)}{3 - 1} = \frac{7}{2}$$

Lines ℓ_1 and ℓ_2 are not parallel because their slopes are not equal.

Quick Check

1 Line ℓ_3 contains $A(-4, 2)$ and $B(3, 1)$. Line ℓ_4 contains $C(-4, 0)$ and $D(8, -2)$. Are ℓ_3 and ℓ_4 parallel? Explain. No; the slope of $\ell_3 = -\frac{1}{7}$, and the slope of $\ell_4 = -\frac{1}{6}$.

Differentiated Instruction Solutions for All Learners

Special Needs L1
Some students may have difficulty seeing pairs of perpendicular lines other than vertical and horizontal lines. Have students use a protractor to confirm the perpendicular lines shown in Example 4.

learning style: tactile

Below Level L2
Review the rules for multiplying and dividing signed numbers before students work with the slopes of perpendicular lines.

learning style: verbal

Slope-intercept form allows you to compare slopes easily in order to decide whether lines are parallel.

2 EXAMPLE Determining Whether Lines are Parallel

Multiple Choice Which line is parallel to $4y - 12x = 20$?

Ⓐ $y = 3x - 1$ Ⓑ $y = -\frac{1}{3}x - 1$
Ⓒ $4y = -12x + 20$ Ⓓ $y = \frac{1}{3}x + 1$

Write $4y - 12x = 20$ in slope-intercept form.

$$4y - 12x = 20$$
$$4y = 12x + 20 \quad \textbf{Add } 12x \textbf{ to each side.}$$
$$y = 3x + 5 \quad \textbf{Divide each side by 4.}$$

The line $4y - 12x = 20$ has slope 3. The line $y = 3x - 1$ is the only answer choice with slope 3. The correct choice is A.

Test-Taking Tip

To compare slopes of two lines, write their equations in slope-intercept form, $y = mx + b$.

Quick Check 2 Are the lines parallel? Explain.

a. $y = -\frac{1}{2}x + 5$ and $2x + 4y = 9$
Yes; both slopes $= -\frac{1}{2}$.

b. $y = -\frac{1}{2}x + 5$ and $2x + 4y = 20$
No; the lines are the same.

You can write an equation for a line parallel to a given line.

3 EXAMPLE Writing Equations of Parallel Lines

Write an equation for the line parallel to $y = -4x + 3$ that contains $(1, -2)$.

Step 1 Identify the slope of the given line.

$$y = \underset{\uparrow \text{ slope}}{-4}x + 3$$

Step 2 Use point-slope form to write an equation for the new line.

$$y - y_1 = m(x - x_1)$$
$$y - (-2) = -4(x - 1) \quad \textbf{Substitute } -4 \textbf{ for } m \textbf{ and } (1, -2) \textbf{ for } (x_1, y_1).$$
$$y + 2 = -4(x - 1) \quad \textbf{Simplify.}$$

Quick Check 3 Write an equation for the line parallel to $y = -x + 4$ that contains $(-2, 5)$.
$y = -x + 3$

2 Slope and Perpendicular Lines

The relationship between perpendicular lines and their slopes is summarized below. These statements will be proved in Lessons 6-6 and 6-7.

Key Concepts

Summary Slopes of Perpendicular Lines

If two nonvertical lines are perpendicular, the product of their slopes is -1.

If the slopes of two lines have a product of -1, the lines are perpendicular.

Any horizontal line and vertical line are perpendicular.

2. Teach

Guided Instruction

Careers

Most buildings have walls that are perpendicular to floors, to ceilings, and to each other. Have students investigate how builders construct these.

Math Tip

After students read the Key Concepts about parallel lines, ask: *How can you state the two conditionals as a biconditional?* **Two distinct nonvertical lines are parallel if and only if their slopes are equal.**

2 EXAMPLE Error Prevention

Remind students that they must compare both the slopes and the *y*-intercepts. Ask: *If the slopes are equal and the y-intercepts are equal, are the lines parallel? Explain.* **No; there is only one line.**

PowerPoint

Additional Examples

1 Line ℓ_1 contains $P(0, 3)$ and $Q(-2, 5)$. Line ℓ_2 contains $R(0, -7)$ and $S(3, -10)$. Are lines ℓ_1 and ℓ_2 parallel? Explain. **Yes; each has slope -1 and different *y*-intercepts.**

2 Are the lines $y = -5x + 4$ and $x = -5y + 4$ parallel? Explain. **No; one line has slope -5 and the other line has slope $-\frac{1}{5}$.**

3 Write an equation in point-slope form for the line parallel to $6x - 3y = 9$ that contains $(-5, -8)$. **$y + 8 = 2(x + 5)$**

Advanced Learners L4

After students complete Example 5, have them work on this problem: Line $y + ax = b$ is perpendicular to line $y - ax = b$. What are the possible values of a?

learning style: verbal

English Language Learners ELL

Review the meaning of *positive slope* and *negative slope*. Then distinguish slope from the *product of the slopes* of two lines. The *product of the slopes* for two nonvertical perpendicular lines is always -1.

learning style: verbal

Guided Instruction

4 EXAMPLE Alternative Method

When lines are perpendicular, their slopes are *negative reciprocals.* Have students check that m_1 and m_2 are negative reciprocals.

5 EXAMPLE Special Needs L1

Students who find the procedure complicated can work with partners.

6 EXAMPLE Diversity

Ask students to describe unusual window designs they have seen elsewhere.

PowerPoint

Additional Examples

4 Line ℓ_1 contains $M(0, 8)$ and $N(4, -6)$. Line ℓ_2 contains $P(-2, 9)$ and $Q(5, 7)$. Are lines ℓ_1 and ℓ_2 perpendicular? Explain. **No; the product of their slopes is 1.**

5 Write an equation for a line perpendicular to $5x + 2y = 1$ that contains (10, 0). $\boldsymbol{y = \frac{2}{5}(x - 10)}$

6 The equation for a line containing a lead strip is $y = \frac{1}{2}x - 9$. Write an equation for a line perpendicular to it that contains (1, 7). $\boldsymbol{y = -2x + 9}$

Resources

- Daily Notetaking Guide 3-7 L3
- Daily Notetaking Guide 3-7—Adapted Instruction L1

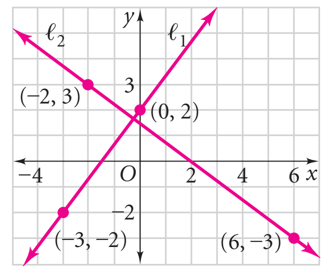
Closure

Explain algebraically why two lines cannot be both parallel and perpendicular. **The product of the slopes m of two parallel lines is m^2. The product of the slopes of two perpendicular lines is -1. A slope m such that $m^2 = -1$ is not a real number.**

You can test whether lines are perpendicular by first noting whether either line is vertical or horizontal. If not, check their slopes. If the product of the slopes is -1, the lines are perpendicular.

4 EXAMPLE Checking for Perpendicular Lines

Algebra Lines ℓ_1 and ℓ_2 are neither vertical nor horizontal. Are they perpendicular? Explain.



Step 1 Find the slope of each line.

$$m_1 = \text{slope of } \ell_1 = \frac{-2 - 2}{-3 - 0} = \frac{-4}{-3} = \frac{4}{3}$$

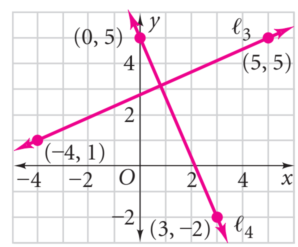
$$m_2 = \text{slope of } \ell_2 = \frac{3 - (-3)}{-2 - 6} = \frac{6}{-8} = -\frac{3}{4}$$

Step 2 Find the product of the slopes.

$$m_1 \cdot m_2 = \frac{4}{3} \cdot -\frac{3}{4} = -1$$

Lines ℓ_1 and ℓ_2 are perpendicular because the product of their slopes is -1.

Quick Check 4 Are ℓ_3 and ℓ_4 perpendicular? Explain.
No; the slope of $\ell_3 = \frac{4}{9}$, and the slope of $\ell_4 = -\frac{7}{3}$, and $\frac{4}{9} \cdot -\frac{7}{3} \neq -1$.



You can write an equation for a line perpendicular to a given line. If the given line is horizontal, write an equation for a vertical line. If the given line is vertical, write an equation for a horizontal line.

5 EXAMPLE Writing Equations for Perpendicular Lines

Write an equation for the line perpendicular to $y = -3x - 5$ that contains $(-3, 7)$.

Step 1 Identify the slope of the given line.

$$y = \underset{\substack{\uparrow \\ \text{slope}}}{-3}x - 5$$

Step 2 Find the slope of the line perpendicular to the given line.
Let m be the slope of the perpendicular line.

$-3m = -1$ **The product of the slopes of perpendicular lines is -1.**

$m = \frac{1}{3}$ **Divide each side by -3.**

Step 3 Use point-slope form to write an equation for the new line.

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

$y - 7 = \frac{1}{3}[x - (-3)]$ **Substitute $\frac{1}{3}$ for m and $(-3, 7)$ for (x_1, y_1).**

$y - 7 = \frac{1}{3}(x + 3)$ **Simplify.**

Vocabulary Tip

Numbers with product -1 are opposite reciprocals. In Example 5, the opposite reciprocal of -3 is $\frac{1}{3}$.

Quick Check 5 Write an equation for the line perpendicular to $5y - x = 10$ that contains $(15, -4)$.
$\boldsymbol{y + 4 = -5(x - 15)}$

6 EXAMPLE **Real-World Connection**

The window at the left includes some perpendicular lead strips. The line that contains $\overline{BC}$ has equation $y = -x + 10$. $\overline{AB}$ is perpendicular to $\overline{BC}$. Write an equation for $\overleftrightarrow{AB}$, the line that contains $\overline{AB}$ and point $(-1, 5)$.

The line that contains $\overline{BC}$ has slope -1. Let m be the slope of $\overleftrightarrow{AB}$.

$-1m = -1$ **The product of the slopes is −1.**

$m = 1$

$\overleftrightarrow{AB}$ has slope 1 and can be written in the form $y = 1x + b$, or $y = x + b$.

$y = x + b$ **$\overleftrightarrow{AB}$ has slope 1.**

$5 = -1 + b$ **Substitute 5 for y and −1 for x.**

$6 = b$ **Add 1 to each side.**

The equation for $\overleftrightarrow{AB}$ is $y = x + 6$.

Quick Check **6** If the equation for a line containing a lead strip on a different window is $y = -\frac{2}{3}x + 15$, write an equation for the line perpendicular to it that contains $(2, 8)$.

$y - 8 = \frac{3}{2}(x - 2)$ or $y = \frac{3}{2}x + 5$

EXERCISES

For more exercises, see *Extra Skill, Word Problem, and Proof Practice.*

Practice and Problem Solving

A Practice by Example

Example 1 (page 174)

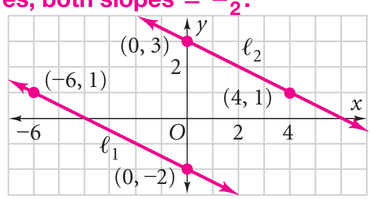
GO for Help

2. No; the slope of $\ell_1 = \frac{1}{3}$ and the slope of $\ell_2 = \frac{1}{2}$.

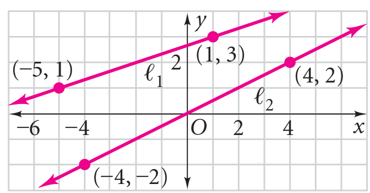
3. No; the slope of $\ell_1 = \frac{3}{2}$, and the slope of $\ell_2 = 2$.

In Exercises 1–5, are lines ℓ_1 and ℓ_2 parallel? Explain, using slope. 2–3. See left.

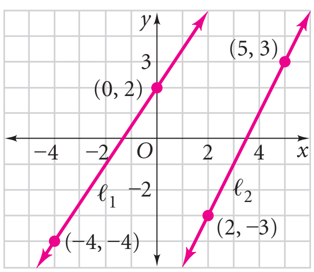
1. Yes; both slopes $= -\frac{1}{2}$.



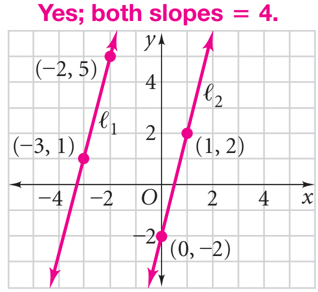
2.



3.



4. Yes; both slopes $= 4$.



5. Line ℓ_1 contains $A(-3, 6)$ and $B(2, 6)$, and line ℓ_2 contains $C(0, 0)$ and $D(7, 0)$.
Yes; both slopes $= 0$.

Example 2 (page 175)

Algebra Are the lines parallel? Explain. 6–11. See margin.

6. $y = 2x + 5$ $y = 2x$	**7.** $y = \frac{3}{4}x - 10$ $y = \frac{3}{4}x + 2$	**8.** $y = -x + 6$ $x + y = 20$
9. $y - 7x = 6$ $y + 7x = 8$	**10.** $3x + 4y = 12$ $6x + 2y = 6$	**11.** $2x + 5y = -1$ $10y = -4x - 20$

3. Practice

Assignment Guide

1 A B 1-15, 29-32, 34, 35, 37

2 A B 16-28, 33, 36, 38-44

C Challenge 45-48

Test Prep 49-52
Mixed Review 53-61

Homework Quick Check

To check students' understanding of key skills and concepts, go over Exercises 6, 18, 34, 36, 40.

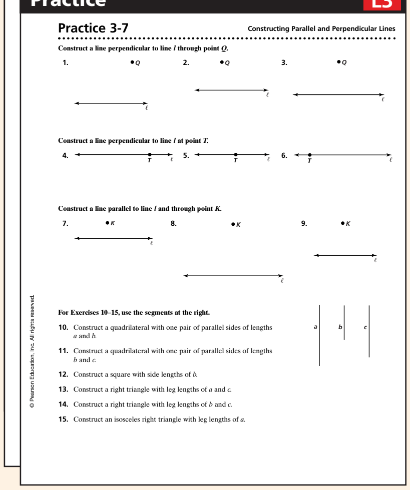
Visual Learners

Exercises 1–4 Lines that do not intersect on the portion of the coordinate plane shown or that appear parallel may not actually be parallel. The only way to be certain that lines are parallel is to compare their slopes.

Exercises 8–11 Remind students to rewrite equations in slope-intercept form.

Differentiated Instruction Resources

GPS Guided Problem Solving L3
Enrichment L4
Reteaching L2
Adapted Practice L1
Practice L3


Practice 3-7 Constructing Parallel and Perpendicular Lines

6. Yes; the lines both have a slope of 2 but different y-intercepts.

7. Yes; the lines both have a slope of $\frac{3}{4}$ but different y-intercepts.

8. Yes; the lines both have a slope of -1 but different y-intercepts.

9. No; one slope $= 7$ and the other slope $= -7$.

10. No; one slope $= -\frac{3}{4}$ and the other slope $= -3$.

11. Yes; the lines both have a slope of $-\frac{2}{5}$ but different y-intercepts.

Exercise 28 Students must correctly transform equations in standard form to slope-intercept form.

Exercise 38 Discuss as a class how the truth value of this theorem changes if the phrase *in a plane* is removed. Have students explain why the resulting statement is false.

Exercise 39 In Chapter 5 students will learn that the shortest distance from a point to a line is along the perpendicular path to that line. Discuss informally why Joe would choose the perpendicular route to the ball.

Exercises 45, 46 These exercises anticipate the study of quadrilaterals in Chapter 6. If necessary, review the distance and midpoint formulas.

12. $y - 3 = -2(x - 0)$ or $y - 3 = -2x$

13. $y - 0 = \frac{1}{3}(x - 6)$ or $y = \frac{1}{3}(x - 6)$

29. slope of $\overline{AB}$ = slope of $\overline{CD} = \frac{2}{3}$; $\overline{AB} \parallel \overline{CD}$ slope of $\overline{BC}$ = slope of $\overline{AD} = -3$; $\overline{BC} \parallel \overline{AD}$

30. slope of $\overline{AB}$ = slope of $\overline{CD} = -\frac{3}{4}$; $\overline{AB} \parallel \overline{CD}$ slope of $\overline{BC}$ = slope of $\overline{AD} = 1$; $\overline{BC} \parallel \overline{AD}$

31. slope of $\overline{AB} = \frac{1}{2}$; slope of $\overline{CD} = \frac{1}{4}$; $\overline{AB} \nparallel \overline{CD}$ slope of $\overline{BC} = -1$; slope of $\overline{AD} = -\frac{1}{2}$; $\overline{BC} \nparallel \overline{AD}$

32. slope of $\overline{AB}$ = slope of $\overline{CD} = 0$; $\overline{AB} \parallel \overline{CD}$ slope of $\overline{BC} = 3$ and slope of $\overline{AD} = \frac{3}{2}$; $\overline{BC} \nparallel \overline{AD}$

45. $\overline{AC}$: $d = \sqrt{(7-9)^2 + (11-1)^2} = \sqrt{104}$

$\overline{BD}$: $d = \sqrt{(13-3)^2 + (7-5)^2} = \sqrt{104}$

$\overline{AC} \cong \overline{BD}$

Example 3 (page 175)

Write an equation for the line parallel to $\overleftrightarrow{AB}$ that contains point C.

12. $\overleftrightarrow{AB}: y = -2x + 1, C(0, 3)$ See margin.

13. $\overleftrightarrow{AB}: y = \frac{1}{3}x, C(6, 0)$ See margin.

14. $\overleftrightarrow{AB}: -x + 2y = 4, C(-2, 4)$ $y - 4 = \frac{1}{2}(x + 2)$

15. $\overleftrightarrow{AB}: 3x + 2y = 12, C(6, -2)$ $y + 2 = -\frac{3}{2}(x - 6)$

Example 4 (page 176)

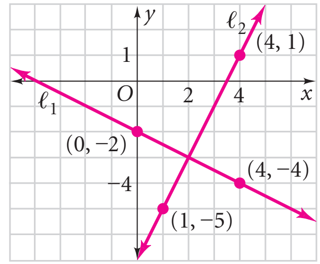
Algebra **Are lines ℓ_1 and ℓ_2 perpendicular? Explain using slope.**

16. Yes; the slope of $\ell_1 = -\frac{1}{2}$, and the slope of $\ell_2 = 2$; $-\frac{1}{2} \cdot 2 = -1$.

17. Yes; the slope of $\ell_1 = -\frac{3}{2}$, and the slope of $\ell_2 = \frac{2}{3}$; $-\frac{3}{2} \cdot \frac{2}{3} = -1$.

18. No; the slope of $\ell_1 = -1$, and the slope of $\ell_2 = \frac{4}{5}$; $-1 \cdot \frac{4}{5} \neq -1$.

19. Yes; the slope of $\ell_1 = -1$, and the slope of $\ell_2 = 1$; $-1 \cdot 1 = -1$.

16.


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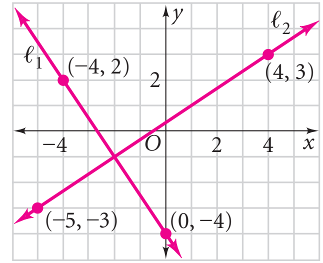

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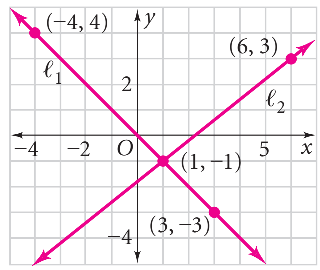

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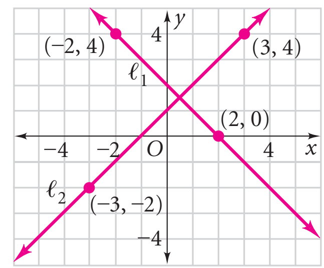


Example 5 (page 176)

Write an equation for the line perpendicular to $\overleftrightarrow{MN}$ that contains point P.

20. $\overleftrightarrow{MN}: y = \frac{2}{3}x, P(6, 6)$ $y - 6 = -\frac{3}{2}(x - 6)$

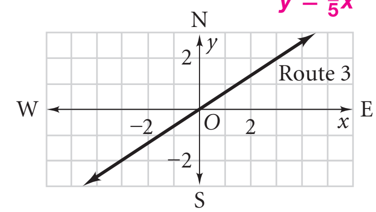
21. $\overleftrightarrow{MN}: y = \frac{1}{2}x - 5, P(4, 0)$ $y = -2(x - 4)$

22. $\overleftrightarrow{MN}: y + 2x = -8, P(4, 4)$ $y - 4 = \frac{1}{2}(x - 4)$

23. $\overleftrightarrow{MN}: 4y + 5x = 20, P(0, 0)$ $y = \frac{4}{5}x$

Example 6 (page 177)

24. **Highway Construction** Highway planners want to construct a road perpendicular to Route 3 at point O. An equation for the Route 3 line is $y = \frac{2}{3}x$. Find an equation for the line for the new road. $y = -\frac{3}{2}x$



B Apply Your Skills

Algebra **Are the lines perpendicular? Explain.**

25. $y = -x - 7$
$y - x = 20$
Yes; $1 \cdot (-1) = -1$.

26. $y = 3$
$x = -2$
Yes; one is vertical and the other is horizontal.

27. $2x - 7y = -42$
$4y = -7x - 2$
No; $\frac{2}{7} \cdot \left(-\frac{7}{4}\right) \neq -1$.

28. **Multiple Choice** Which line is perpendicular to $3y + 2x = 12$? A

Ⓐ $6x - 4y = 24$ Ⓑ $y + 3x = -2$

Ⓒ $2x + 3y = 6$ Ⓓ $y = -2x + 6$

Use slopes to find whether the opposite sides of quadrilateral $ABCD$ are parallel. 29–32. See margin.

29. $A(0, 2), B(3, 4), C(2, 7), D(-1, 5)$

30. $A(-3, 1), B(1, -2), C(0, -3), D(-4, 0)$

31. $A(1, 1), B(5, 3), C(7, 1), D(3, 0)$

32. $A(1, 0), B(4, 0), C(3, -3), D(-1, -3)$

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33. **Open-Ended** Write equations for two perpendicular lines that have the same y-intercept and do not pass through the origin. See left.

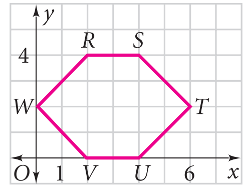
33. Answers may vary. Sample: $y = \frac{4}{5}x + 5$, $y = -\frac{5}{4}x + 5$

34. **Writing** Can the y-intercepts of two parallel lines be the same? Explain.
No; two parallel lines with the same *y*-intercept are actually only one line.

46. slope of $\overline{AC} = -5$; slope of $\overline{BD} = \frac{1}{5}$; since $-5 \cdot \frac{1}{5} = -1$, $\overline{AC} \perp \overline{BD}$; midpoint $\overline{AC} = (8, 6)$; midpoint $\overline{BD} = (8, 6)$; since the midpoints are the same, the diagonals bisect each other.

35. $\overline{RS}$ and $\overline{VU}$ are horizontal with slope = 0; $\overline{RS} \parallel \overline{VU}$; slope of $\overline{RW}$ = slope of $\overline{UT}$ = 1; $\overline{RW} \parallel \overline{UT}$; slope of $\overline{WV}$ = slope of $\overline{ST}$ = −1; $\overline{WV} \parallel \overline{ST}$

35. Use slope to show that the opposite sides of hexagon $RSTUVW$ at the right are parallel.



Exercise 35

36. Use slope to determine whether a triangle with vertices $G(3, 2)$, $H(8, 5)$, and $K(0, 10)$ is a right triangle. Explain. No; no pairs of slopes have a product of −1.

Developing Proof **Use slope to explain why each theorem is true for three lines in the coordinate plane.**

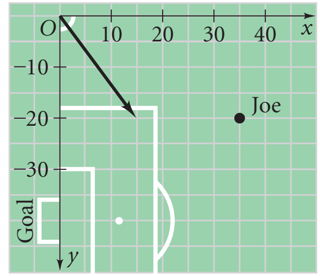
37. Theorem 3-9: If two lines are parallel to the same line, then they are parallel to each other. The lines will have the same slope.

38. Theorem 3-10: In a plane, if two lines are perpendicular to the same line, then they are parallel to each other. When lines are ⊥, the product of their slopes is −1. So, two lines ⊥ to the same line must have the same slope.

Real-World Connection

For a corner kick, the ball is placed within a quarter circle of radius 1 yd.

39. **Soccer** The coordinate system at the right is designed for a soccer field. Each unit represents one yard. Joe is at point $P(35, -20)$. The path of the ball from a corner kick is represented by the equation $y = -\frac{4}{3}x$. To have the best chance for a shot on goal, Joe wants to run toward the ball so that his path meets the path of the ball at a right angle.



a. Find an equation for the line on which Joe should run. $y + 20 = \frac{3}{4}(x - 35)$

b. **Critical Thinking** Why is point-slope form the best choice for the equation? because you are given a point and can quickly find the slope

Determine whether $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ are *parallel*, *perpendicular*, or *neither*.

40. $A\left(-1, \frac{1}{2}\right), B(-1, 2), C(3, 7), D(3, -1)$ ∥

41. $A(-2, 3), B(-2, 5), C(1, 4), D(2, 4)$ ⊥

42. $A(2, 4), B(5, 4), C(3, 2), D(0, 8)$ neither

43. $A(-3, 2), B(5, 1), C(2, 7), D(1, -1)$ ⊥

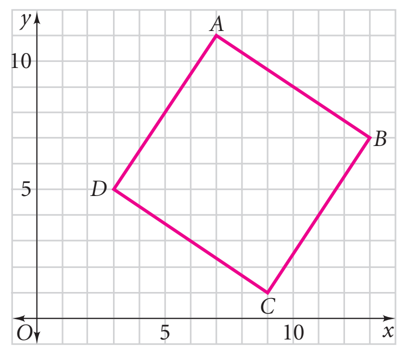
Go Online
PHSchool.com
For: Graphing calculator procedures
Web Code: aue-2122

44. **Graphing Calculator** Use your graphing calculator to find the slope of $\overleftrightarrow{AB}$ in Exercise 43. Enter the x-coordinates of A and B into the L_1 list of your list editor. Enter the y-coordinates into the L_2 list. In your STAT CALC menu select LinReg $(ax + b)$. ENTER to find the slope a. Repeat to find the slope of $\overleftrightarrow{CD}$. Are $\overleftrightarrow{AB}$ and $\overleftrightarrow{CD}$ parallel, perpendicular, or neither? ⊥

Challenge

45. Show that the diagonals of the figure at the right are congruent. See margin, p. 178.

46. Show that the diagonals of the figure at the right are perpendicular bisectors of each other. See margin, p.178.



Exercises 45 and 46

47. a. Graph the points $P(2, 2)$, $Q(7, 4)$, and $R(3, 5)$. a–c. See margin.

b. Find the coordinates of a point S that, along with points P, Q, and R, will form the vertices of a quadrilateral whose opposite sides are parallel. Graph the quadrilateral.

c. Repeat part (b), finding a different point S and graphing the new quadrilateral.

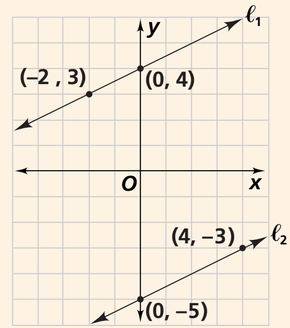
48. A triangle has vertices $L(-5, 6)$, $M(-2, -3)$, and $N(4, 5)$. Write an equation for the line perpendicular to $\overline{LM}$ that contains point N. $y - 5 = \frac{1}{3}(x - 4)$

4. Assess & Reteach

PowerPoint

Lesson Quiz

1. Are lines ℓ_1 and ℓ_2 parallel? Explain.



Yes; the lines have the same slope and different y-intercepts.

2. Are the lines $x + 4y = 8$ and $2x + 6y = 16$ parallel? Explain. No; their slopes are not equal.

3. Write an equation in point-slope form for the line parallel to $-18x + 2y = 7$ that contains (3, 1). $y - 1 = 9(x - 3)$

4. Are the lines $y = \frac{2}{3}x + 5$ and $3x + 2y = 10$ perpendicular? Explain. Yes; the product of their slopes is −1.

5. Write an equation in point-slope form for the line perpendicular to $y = -\frac{1}{6}x - 2$ that contains $(-5, -8)$. $y + 8 = 6(x + 5)$

Alternative Assessment

Have students draw a pair of parallel lines and a pair of perpendicular lines on a coordinate plane and then use slopes to prove that the lines are parallel and perpendicular.

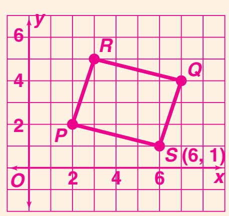
Test Prep

Resources

For additional practice with a variety of test item formats:

- Standardized Test Prep, p. 193
- Test-Taking Strategies, p. 188
- Test-Taking Strategies with Transparencies

47.a–b. Answers may vary. Sample:



c. The other possible locations for S are (−2, 3) and (8, 7).

Checkpoint Quiz

Use this Checkpoint Quiz to check students' understanding of the skills and concepts of Lessons 3-5 through 3-7.

Resources
Grab & Go
- Checkpoint Quiz 2

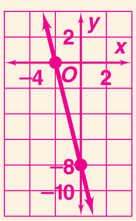
52. [2] a. slope of line c: $\frac{1-(-2)}{-4-2} = \frac{3}{-6} = -\frac{1}{2}$; slope of line $\perp$ to c: 2

b. 0

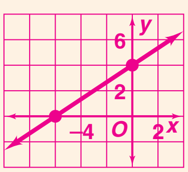
[1] at least one correct slope

Checkpoint Quiz 2

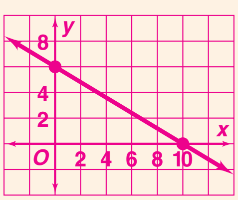
4.



5.



6.



Test Prep

Multiple Choice

49. What is the slope of a line parallel to the line $6x - 4y = 12$? **B**
A. $-\frac{3}{2}$ B. $\frac{3}{2}$ C. $\frac{4}{3}$ D. $-\frac{4}{3}$

50. The slope of a line is 6. What is the slope of a line perpendicular to it? **J**
F. 6 G. -6 H. $\frac{1}{6}$ J. $-\frac{1}{6}$

51. Line f contains the points $(5, -4)$ and $(4, -6)$. What is the slope of a line perpendicular to it? **C**
A. 2 B. $\frac{1}{2}$ C. $-\frac{1}{2}$ D. -2

Short Response

52. Line c contains the points $(2, -2)$ and $(-4, 1)$. **a–b. See margin.**
a. What is the slope of a line perpendicular to line c?
b. What is the y-intercept of the line perpendicular to line c that contains $(1, 2)$?

Mixed Review

GO for Help

Lesson 3-6 **Algebra** Write an equation for the line containing the given points.

53. $A(0, 3), B(6, 0)$ $y - 3 = -\frac{1}{2}(x - 0)$ or $y - 3 = -\frac{1}{2}x$

54. $C(-4, 2), D(-1, 7)$ $y - 2 = \frac{5}{3}(x + 4)$

55. $E(3, -2), F(-5, -8)$ $y + 2 = \frac{3}{4}(x - 3)$

Lesson 2-4 Name the property that justifies each statement.

56. $\angle 4 \cong \angle 4$ **Refl. Prop. of ≅**

57. If $m\angle B = 8$, then $2m\angle B = 16$. **Mult. Prop. of =**

58. $-3x + 6 = 3(-x + 2)$ **Dist. Prop.**

59. If $\overline{RS} \cong \overline{MN}$, then $\overline{MN} \cong \overline{RS}$. **Symm. Prop. of ≅**

Lesson 2-3 Use the Law of Syllogism to draw a conclusion.

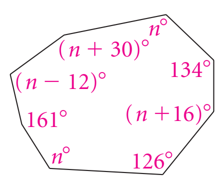
60. If you are in geometry class, then you are in math class. If you are in math class, then you are at school.
If you are in geometry class, then you are at school.

61. If you travel to Switzerland, then you travel to Europe. If you travel to Europe, then you have a passport.
If you travel to Switzerland, then you have a passport.

Checkpoint Quiz 2 — Lessons 3-5 through 3-7

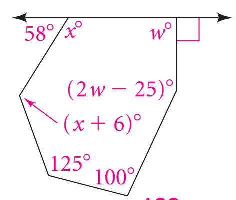
Use the number of sides to name the polygon. Then find the value of each variable.

1.



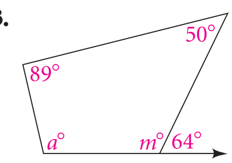
octagon; $n = 125$

2.



hexagon; $x = 122$; $w = 90$

3.



quad; $a = 105$; $m = 116$

Algebra Graph each line using intercepts. **4–6. See margin.**

4. $4x + y = -8$

5. $-2x + 3y = 12$

6. $3x + 5y = 30$

Find the slopes of $\overleftrightarrow{RS}$ and $\overleftrightarrow{TV}$. Then determine whether $\overleftrightarrow{RS}$ and $\overleftrightarrow{TV}$ are parallel, perpendicular, or neither. Explain.

7. $R(-2, 6), S(3, 4), T(3, 5), V(0, 0)$

8. $R(6, -1), S(7, 0), T(3, -4), V(0, -1)$

9. $R(9, 1), S(5, 6), T(3, 8), V(-2, 4)$

10. $R(5, -7), S(-4, -9), T(6, 2), V(-3, 0)$

7. slope of $\overleftrightarrow{RS} = -\frac{2}{5}$; slope of $\overleftrightarrow{TV} = \frac{5}{3}$; neither

8. slope of $\overleftrightarrow{RS} = 1$; slope of $\overleftrightarrow{TV} = -1$; $\perp$

9. slope of $\overleftrightarrow{RS} = -\frac{5}{4}$; slope of $\overleftrightarrow{TV} = \frac{4}{5}$; $\perp$

10. slope of $\overleftrightarrow{RS} = \frac{2}{9}$; slope of $\overleftrightarrow{TV} = \frac{2}{9}$; ∥