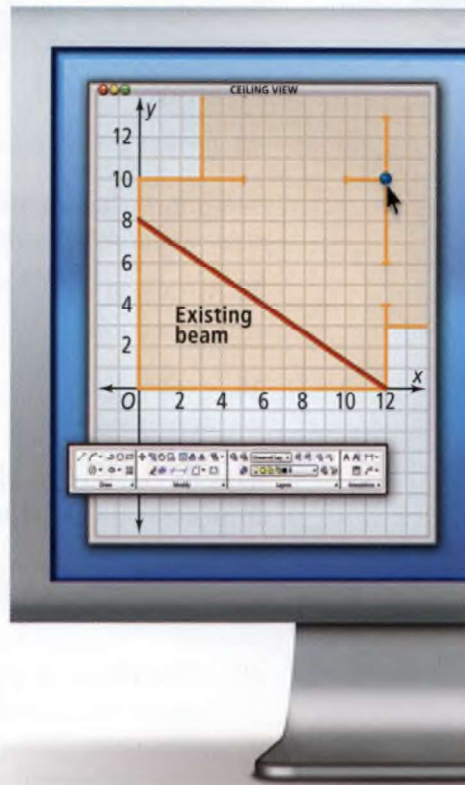


Problem 4 Solving a Real-World Problem STEM

Architecture An architect uses software to design the ceiling of a room. The architect needs to enter an equation that represents a new beam. The new beam will be perpendicular to the existing beam, which is represented by the red line. The new beam will pass through the corner represented by the blue point. What is an equation that represents the new beam?



Plan

Have you seen a problem like this before?

Yes. You wrote the equation of a perpendicular line in Problem 3. Follow the same steps here after you calculate the slope of the line from the graph.

Step 1 Use the slope formula to find the slope of the red line that represents the existing beam.

$$\begin{aligned} m &= \frac{4 - 6}{6 - 3} && \text{Points } (3, 6) \text{ and } (6, 4) \\ & && \text{are on the red line.} \\ &= -\frac{2}{3} && \text{Simplify.} \end{aligned}$$

The slope of the line that represents the existing beam is $-\frac{2}{3}$.

Step 2 Find the opposite reciprocal of the slope from Step 1. The opposite reciprocal of $-\frac{2}{3}$ is $\frac{3}{2}$.

Step 3 Use point-slope form to write an equation. The slope of the line that represents the new beam is $\frac{3}{2}$. It will pass through $(12, 10)$. An equation that represents the new beam is $y - 10 = \frac{3}{2}(x - 12)$ or, in slope-intercept form, $y = \frac{3}{2}x - 8$.

Got It? 4. What equation could the architect enter to represent a second beam whose graph will pass through the corner at $(0, 10)$ and be parallel to the existing beam? Give your answer in slope-intercept form.

Lesson Check

Do you know HOW?

- Which equations below have graphs that are parallel to one another? Which have graphs that are perpendicular to one another?
 $y = -\frac{1}{6}x$ $y = 6x$ $y = 6x - 2$
- What is an equation of the line that passes through $(3, -1)$ and is parallel to $y = -4x + 1$? Give your answer in slope-intercept form.
- What is an equation of the line that passes through $(2, -3)$ and is perpendicular to $y = x - 5$? Give your answer in slope-intercept form.

Do you UNDERSTAND? MATHEMATICAL PRACTICES

- Vocabulary** Tell whether the two numbers in each pair are opposite reciprocals.
 a. $-2, \frac{1}{2}$ b. $\frac{1}{4}, 4$ c. $5, -5$
- Open-Ended** Write equations of two parallel lines.
- Compare and Contrast** How is determining if two lines are parallel similar to determining if they are perpendicular? How are the processes different?



Practice and Problem-Solving Exercises

A Practice

Write an equation in slope-intercept form of the line that passes through the given point and is parallel to the graph of the given equation.

See Problem 1.

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

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

9. $(1, -3); y + 2 = 4(x - 1)$

10. $(2, -1); y = -\frac{3}{2}x + 6$

11. $(0, 0); y = \frac{2}{3}x + 1$

12. $(4, 2); x = -3$

Determine whether the graphs of the given equations are *parallel*, *perpendicular*, or *neither*. Explain.

See Problem 2.

13. $y = x + 11$

14. $y = \frac{3}{4}x - 1$

15. $y = -2x + 3$

$y = -x + 2$

$y = \frac{3}{4}x + 29$

$2x + y = 7$

16. $y - 4 = 3(x + 2)$

17. $y = -7$

18. $y = 4x - 2$

$2x + 6y = 10$

$x = 2$

$-x + 4y = 0$

Write an equation in slope-intercept form of the line that passes through the given point and is perpendicular to the graph of the given equation.

See Problem 3.

19. $(0, 0); y = -3x + 2$

20. $(-2, 3); y = \frac{1}{2}x - 1$

21. $(1, -2); y = 5x + 4$

22. $(-3, 2); x - 2y = 7$

23. $(5, 0); y + 1 = 2(x - 3)$

24. $(1, -6); x - 2y = 4$

25. **Urban Planning** A path for a new city park will connect the park entrance to Main Street. The path should be perpendicular to Main Street. What is an equation that represents the path?



See Problem 4.

26. **Bike Path** A bike path is being planned for the park in Exercise 25. The bike path will be parallel to Main Street and will pass through the park entrance. What is an equation of the line that represents the bike path?

B Apply

27. Identify each pair of parallel lines. Then identify each pair of perpendicular lines.

line $a: y = 3x + 3$

line $b: x = -1$

line $c: y - 5 = \frac{1}{2}(x - 2)$

line $d: y = 3$

line $e: y + 4 = -2(x + 6)$

line $f: 9x - 3y = 5$

Determine whether each statement is *always*, *sometimes*, or *never* true. Explain.

28. A horizontal line is parallel to the x -axis.

29. Two lines with positive slopes are parallel.

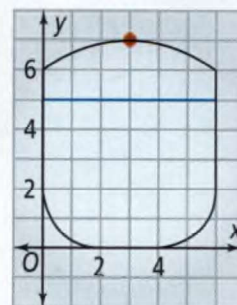
30. Two lines with the same slope and different y -intercepts are perpendicular.

31. **Reasoning** For an arithmetic sequence, the first term is $A(1) = 3$. Each successive term adds 2 to the previous term. Another arithmetic sequence has the rule $B(n) = 5 + (n - 1)d$, where n is the term number and d is the common difference. If the graphs of the two sequences are parallel, what is the value of d ? Explain.

32. **Reasoning** Will the graph of the line represented by the table intersect the graph of $y = 4x + 5$? Explain.

x	-1	0	1	2
y	-1	3	7	11

33. **Think About a Plan** A designer is creating a new logo, as shown at the right. The designer wants to add a line to the logo that will be perpendicular to the blue line and pass through the red point. What equation represents the new line?



34. **Reasoning** For what value of k are the graphs of $12y = -3x + 8$ and $6y = kx - 5$ parallel? For what value of k are they perpendicular?
35. **Agriculture** Two farmers use combines to harvest corn from their fields. One farmer has 600 acres of corn, and the other has 1000 acres of corn. Each farmer's combine can harvest 100 acres per day. Write two equations for the number of acres y of corn *not* harvested after x days. Are the graphs of the equations *parallel*, *perpendicular*, or *neither*? How do you know?

Challenge

36. **Geometry** In a rectangle, opposite sides are parallel and adjacent sides are perpendicular. Figure $ABCD$ has vertices $A(-3, 3)$, $B(-1, -2)$, $C(4, 0)$, and $D(2, 5)$. Show that $ABCD$ is a rectangle.
37. **Geometry** A right triangle has two sides that are perpendicular to each other. Triangle PQR has vertices $P(4, 3)$, $Q(2, -1)$, and $R(0, 1)$. Determine whether PQR is a right triangle. Explain your reasoning.

Standardized Test Prep

SAT/ACT

38. Which equation represents the graph of a line parallel to the line at the right?

(A) $y = \frac{1}{2}x + 5$

(C) $y = -2x + 4$

(B) $y = 2x - 6$

(D) $y = -\frac{1}{2}x - 2$

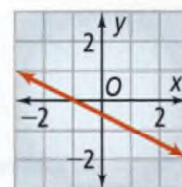
39. What is the solution of $(5x - 1) + (-2x + 7) = 9$?

(F) $\frac{3}{7}$

(G) 1

(H) 3

(I) 5



Short Response

40. Sal's Supermarket sells cases of twenty-four 12-oz bottles of water for \$15.50. Shopper's World sells 12-packs of 12-oz bottles of water for \$8.15. Which store has the better price per bottle? Explain.

Mixed Review

Graph each equation using x - and y -intercepts.

See Lesson 5-5.

41. $x + y = 8$

42. $2x + y = -3$

43. $x - 3y = -6$

Get Ready! To prepare for Lesson 5-7, do Exercises 44-47.

Write an equation in slope-intercept form of the line that passes through the given points.

See Lesson 5-3.

44. $(1, 1), (3, 7)$

45. $(2, 5), (12, 1)$

46. $(0.5, 2), (4.5, 3)$

47. $(13, 20), (6, 60)$