

## 4.4 Exercises

### Concept Check

**Fill-in-the-Blank.** Complete each sentence using information found in this section.

- Perpendicular lines have slopes that are \_\_\_\_\_ of each other.
- The point-slope form for an equation is \_\_\_\_\_.
- Parallel lines have the \_\_\_\_\_ slope.
- Lines represented by the equation  $Ax + By = C$  are in \_\_\_\_\_ form.
- In the equation  $y - y_1 = m(x - x_1)$ ,  $m$  represents the \_\_\_\_\_.
- \_\_\_\_\_ lines are of the form  $x = a$ .

**True/False.** Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

- Given two perpendicular lines (neither of which have slope 0), we know that one has a positive slope and the other has a negative slope.
- If Line 2 is parallel to Line 3, then the slope of Line 2 equals the slope of Line 3.
- A line perpendicular to a horizontal line has a slope that is undefined.
- All pairs of lines are either parallel or perpendicular.

### Practice

Find **a.** the slope, **b.** a point on the line, and **c.** the graph of the line for the following equations in point-slope form.

- |                                 |                    |                                  |
|---------------------------------|--------------------|----------------------------------|
| 1. $y - 1 = 2(x - 3)$           | 3. $y + 2 = -5(x)$ | 5. $y - 3 = -\frac{1}{4}(x + 2)$ |
| 2. $y - 4 = \frac{1}{2}(x - 1)$ | 4. $y = -(x + 8)$  | 6. $y + 6 = \frac{1}{3}(x - 7)$  |

Find an equation in standard form for the line passing through the given point with the given slope. Graph the line. See Examples 1 and 2.

- |                      |                                     |   |
|----------------------|-------------------------------------|---|
| 7. $(-2, 1); m = -2$ | 11. $(-3, 6); m = \frac{1}{2}$      | 14. $(-1, -1); m = -\frac{1}{4}$                              |
| 8. $(3, 4); m = 3$   | 12. $(-3, -1);$<br>$m$ is undefined | 15. $\left(-2, \frac{1}{3}\right); m = \frac{2}{3}$           |
| 9. $(5, -2); m = 0$  | 13. $(7, 10); m = \frac{3}{5}$      | 16. $\left(\frac{5}{2}, \frac{1}{2}\right); m = -\frac{4}{3}$ |

Find an equation in slope-intercept form for the line passing through the two given points. See Example 3.

17.  $(-5, 2); (3, 6)$

18.  $(-3, 4); (2, 1)$

19.  $(-5, 1); (2, 0)$

20.  $(-4, -4); (3, 1)$

21.  $(0, 2); \left(1, \frac{3}{4}\right)$

22.  $\left(\frac{5}{2}, 0\right); \left(2, -\frac{1}{3}\right)$

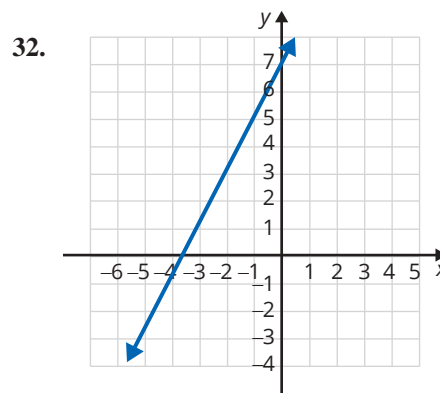
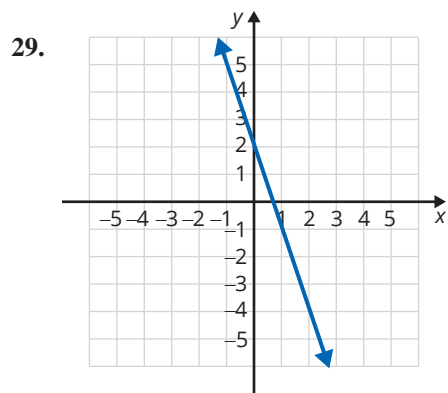
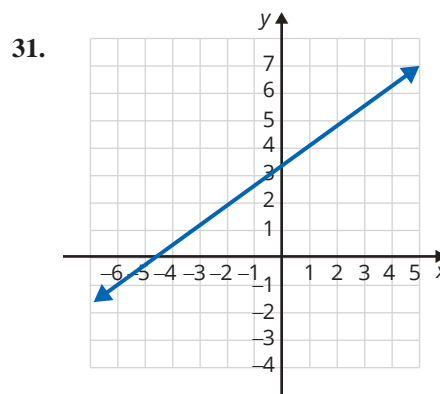
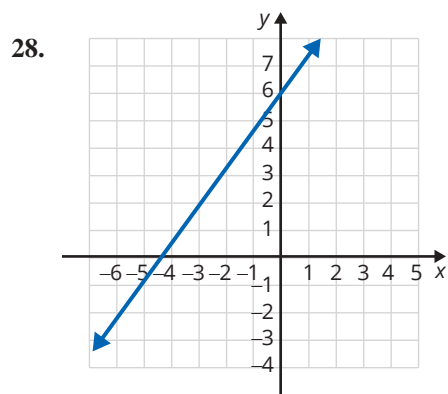
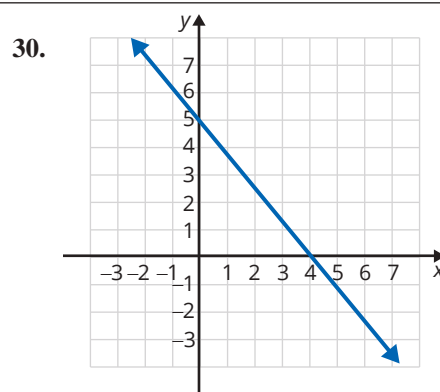
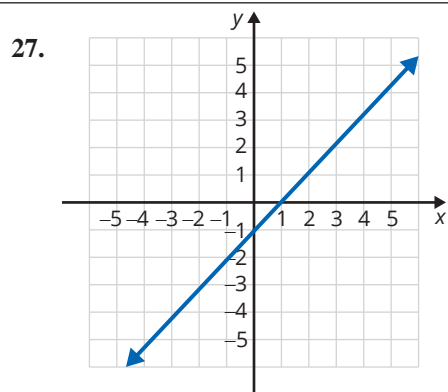
23.  $(2, -5); (4, -5)$

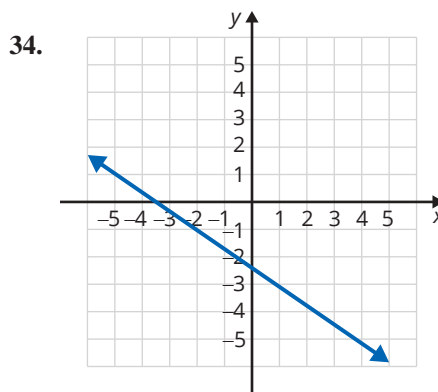
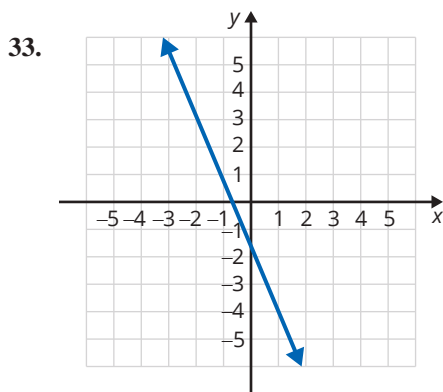
24.  $(0, 4); \left(1, \frac{1}{2}\right)$

25.  $(-2, 6); (3, 1)$

26.  $(8, 2); (0, 0)$

Find an equation in standard form for each line shown. See Example 4.





Find an equation in slope-intercept form that satisfies each set of conditions. See Examples 5 and 6.

35. Find an equation for the horizontal line through the point  $(-2, 6)$ .
36. Find an equation for the vertical line through the point  $(-1, -4)$ .
37. Write an equation for the line parallel to the  $x$ -axis and containing the point  $(2, 7)$ .
38. Find an equation for the line parallel to the  $y$ -axis and containing the point  $(2, -4)$ .
39. Find an equation for the line perpendicular to  $x = 4$  and that passes through  $(-1, 7)$ .
40. Find an equation for the line parallel to the line  $-6y = 1$  and containing the point  $(-3, 2)$ .
41. Write an equation for the line parallel to the line  $2x - y = 4$  and containing the origin. Graph both lines.
42. Find an equation for the line parallel to  $7x - 3y = 1$  and containing the point  $(1, 0)$ . Graph both lines.
43. Write an equation for the line parallel to  $5x = 7 + y$  and through the point  $(-1, -3)$ . Graph both lines.
44. Write an equation for the line that contains the point  $(2, 2)$  and is perpendicular to the line  $4x + 3y = 4$ . Graph both lines.
45. Find an equation for the line that passes through the point  $(4, -1)$  and is perpendicular to the line  $5x - 3y + 4 = 0$ . Graph both lines.
46. Write an equation for the line that is perpendicular to  $8 - 3x - 2y = 0$  and passes through the point  $(-4, -2)$ .
47. Write an equation for the line through the origin that is perpendicular to  $3x - y = 4$ .
48. Find an equation for the line that is perpendicular to  $2x + y = 5$  and that passes through  $(6, -1)$ .
49. Write an equation for the line that is perpendicular to  $2x - y = 7$  and has the same  $y$ -intercept as  $x - 3y = 6$ .
50. Find an equation for the line with the same  $y$ -intercept as  $5x + 4y = 12$  and that is perpendicular to  $3x - 2y = 4$ .
51. Show that the points  $A(-2, 4)$ ,  $B(0, 0)$ ,  $C(6, 3)$ , and  $D(4, 7)$  are the vertices of a rectangle. (Plot the points and show that opposite sides are parallel and that adjacent sides are perpendicular.)
52. Show that the points  $A(0, -1)$ ,  $B(3, -4)$ ,  $C(6, 3)$ , and  $D(9, 0)$  are the vertices of a parallelogram. (Plot the points and show that opposite sides are parallel.)

Determine whether each pair of lines is **a.** parallel, **b.** perpendicular, or **c.** neither. Graph both lines. (**Hint:** Write the equations in slope-intercept form and then compare slopes.)

$$53. \begin{cases} y = -2x + 3 \\ y = -2x - 1 \end{cases}$$

$$54. \begin{cases} y = 3x + 2 \\ y = -\frac{1}{3}x + 6 \end{cases}$$

$$55. \begin{cases} 4x + y = 4 \\ x - 4y = 8 \end{cases}$$

$$56. \begin{cases} 2x + 3y = 5 \\ 3x + 2y = 10 \end{cases}$$

$$57. \begin{cases} 2x + 2y = 9 \\ 2x - y = 6 \end{cases}$$

$$58. \begin{cases} 3x - 4y = 16 \\ 4x + 3y = 15 \end{cases}$$

## Applications

Solve.

59. The cost for an airline to fly from Raleigh, NC, to Nashville, TN, is \$5000. The airline charges \$100 for the one-way ticket from Raleigh to Nashville.
- Find an equation for the profit  $P$  made by the airline on this one-way flight if they sell  $t$  tickets.
  - Use the equation found in part a. to determine the number of tickets that must be sold for the airline to “break even;” that is, for the profit to be equal to 0?
60. A scrapbooking club offers a monthly sticker subscription that is \$9.95 for any selection of 100 stickers, then charges \$0.10 for each additional sticker over 100.
- Write an equation for the total bill,  $b$ , in a month in which you order  $s$  stickers (where  $s$  is at least 100).
  - Jenny’s bill last month was \$27.85. How many stickers did she order?
61. Betsy earns 10 hours of paid time off (PTO) per month and the accumulated hours rollover each month. Two months into the current year, she has accumulated a total of 80 hours of PTO. Let  $y$  be the number of PTO hours accumulated and  $x$  be the number of months.
- Graph the line that represents her projected PTO accumulation for the current calendar year if she does not use any PTO. (Graph should specify that  $x$ -axis is months and  $y$ -axis is hours of PTO.)
  - Write the equation in point-slope form that represents Betsy’s projected PTO accumulation.
62. The price  $p$  of a college textbook increases as the number of pages  $n$  increases. In fact, the price increases \$20 for every 100 pages that are added to the textbook.
- Assuming there are no “fixed” costs, find an equation for the price of a textbook in terms of the number of pages.
  - Use the equation found in part a. to approximate the price of a 560-page textbook.
63. A taxi charges a fare of \$5.00 plus \$0.25 per eighth of a mile for a ride.
- Find an equation for the fare  $f$  in terms of the number of miles  $m$ .
  - Use the equation found in part a. to determine the cost for a 15-mile ride.

64. Natalie invested some money in a simple interest savings fund. After 2 years, she earned \$120 in interest. After 5 years, she earned \$300 in interest.
- Write two ordered pairs from the information given where  $x$  represents the time in years and  $y$  represents the amount of interest earned.
  - Find the slope of the line which contains the two ordered pairs from part a.
  - Write the point-slope equation that models the situation.
  - Rewrite this equation in  $y = mx + b$  form.
65. An archaeology crew finds the foundation of a house during a dig. The corners of the foundations are plotted on their grid map at the following points:  $(1, 7)$ ,  $(3, 2)$ ,  $(9, 4)$ , and  $(7, 9)$ .
- Plot the points on the coordinate plane.
  - Find the slope of each side of the foundation.
  - Are any of the sides parallel? If so, which sides?
  - Are any of the sides perpendicular to each other? If so, which sides?
  - Is the foundation in the form of a geometric shape? If so, which shape?

## Writing & Thinking

66. Ramps for persons with disabilities are now built into most buildings and walkways. (If ramps are not present in a building, then there must be elevators.) What do you think that the slope of a ramp should be in order to be considered accessible? Look in your library or contact your local building permit office to find the recommended slope for such ramps.