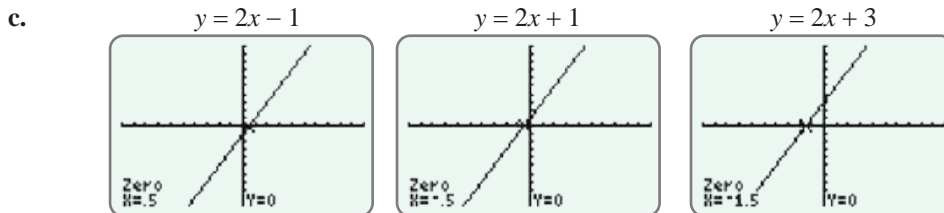
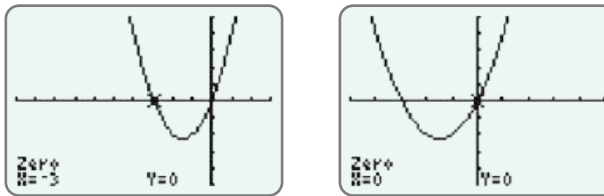


Note

The standard window shows 96 pixels across the window and 64 pixels up and down the window. This gives a ratio of 3 to 2 and can give a slightly distorted view of the actual graph because the vertical pixels are squeezed into a smaller space. For Example 9c, the graphs of all three functions are in the standard window. Experiment by changing the window to a square window, say -9 to 9 for x and -6 to 6 for y . Then graph the functions and notice the slight differences (and better representation) in the appearances on the display.

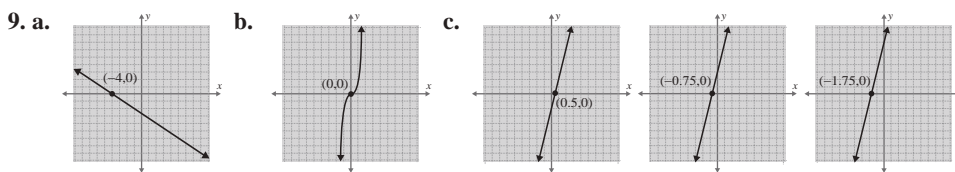
- b. Since the graph of this function has two x -intercepts, we have shown the graph twice. Each graph shows the coordinates of a distinct x -intercept.



Now work margin exercise 9.

Margin Exercise Answers

1. a. $D = \{4, 7, 3\}$; b. $D = \{-2, -4, 0\}$; 2. a. $D = [-5, 6]$; b. $D = (-\infty, 3]$
 $R = \{5, 3, 6\}$ $R = \{3, -3, 0\}$ $R = [-5, 5]$ $R = (-\infty, \infty)$
3. a. not a function b. function 4. a. not a function; $D = \{-7, -3, 0, 2, 4, 5\}$
 $R = \{-2, 0, 2, 3, 6\}$
- b. function; $D = (-\infty, \infty)$ c. not a function; $D = [-5, 7]$ 5. $D = (-\infty, -3) \cup (-3, \infty)$
 $R = [-2, \infty)$ $R = [-1, 5]$ or $x \neq -3$
6. a. $g(3) = 7$ b. $g(-2) = -8$ c. $g(0) = -2$ 7. a. $f(1) = 4$ b. $f(0) = 5$ c. $f(-3) = -16$ 8. a. $f(4) = -5$
b. $f(-4) = -2$ c. $f(-2) = -1$



4.5 Exercises

Concept Check

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

- The equation $y = mx + b$ represents a linear function and $f(x) = mx + b$ is the same equation written in _____ notation.
- The _____ line test can be used to determine if a relation is a function.
- The set of all first coordinates in a relation is the _____, D .
- The set of all second coordinates in a relation is the _____, R .

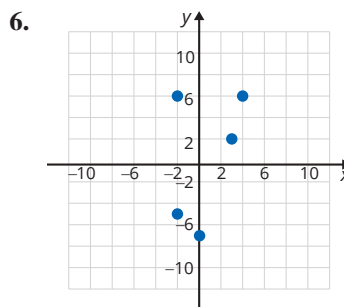
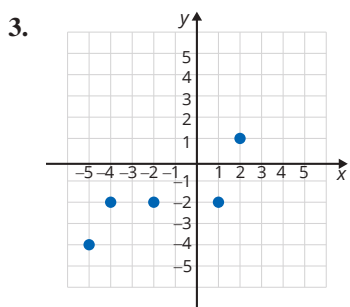
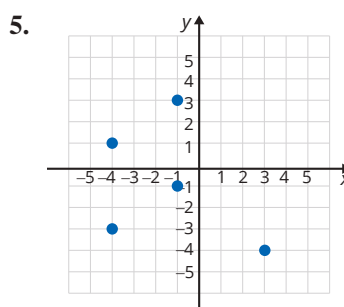
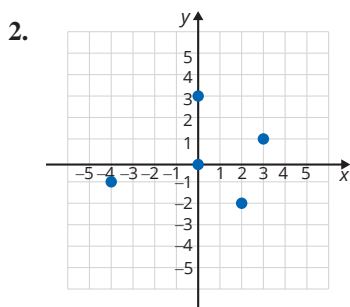
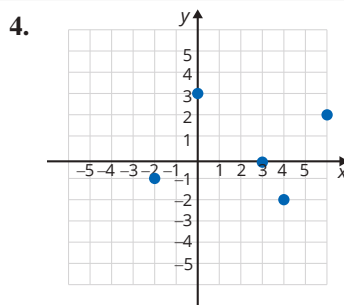
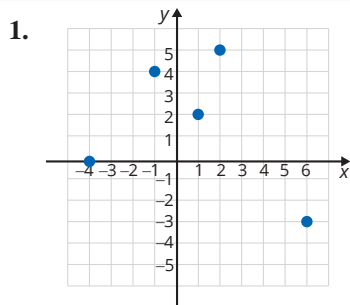
5. In the graph of a relation, the x -axis is called the _____ axis.
6. In the graph of a relation, the y -axis is called the _____ axis.

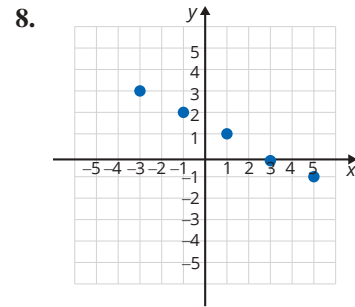
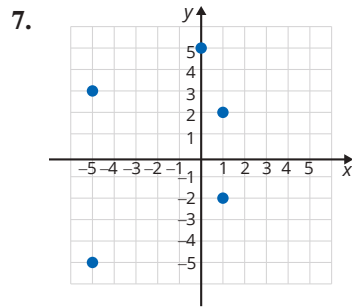
True/False. Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

7. If the domain of a linear function is not explicitly stated, the implied domain is the set of all values of x that produce real values for y .
8. A relation is a function in which each domain element has exactly one corresponding range element.
9. In a function, the range elements can have more than one corresponding domain element.
10. If $s = \{(1, -6), (3, 5), (4, 0), (1, 2)\}$, then s is a function.

Practice

List the sets of ordered pairs that correspond to the points. State the domain and range and indicate which of the relations are also functions. See Examples 1 through 3.





Graph the relations. State the domain and range and indicate which of the relations are functions. See Examples 1 through 3.

9. $f = \{(0, 0), (1, 6), (4, -2), (-3, 5), (2, -1)\}$

10. $h = \{(1, -5), (2, -3), (-1, -3), (0, 2), (4, 3)\}$

11. $g = \{(-4, 4), (-3, 4), (1, 4), (2, 4), (3, 4)\}$

12. $f = \{(-3, -3), (0, 1), (-2, 1), (3, 1), (5, 1)\}$

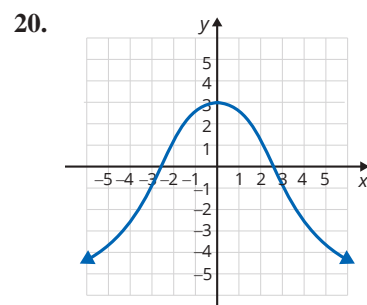
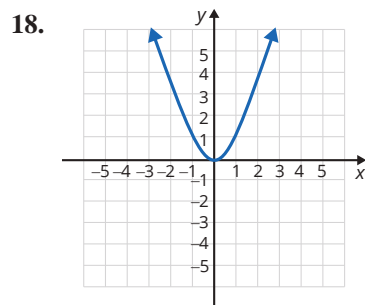
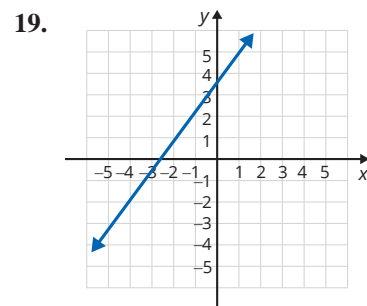
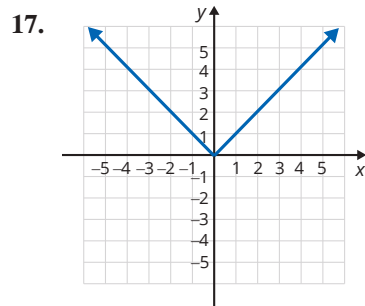
13. $s = \{(0, 2), (-1, 1), (2, 4), (3, 5), (-3, 5)\}$

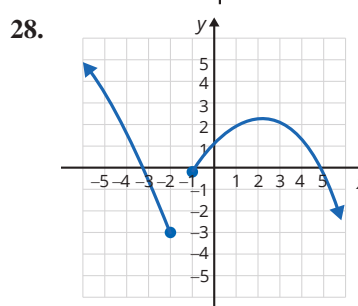
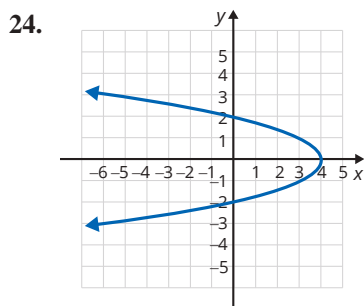
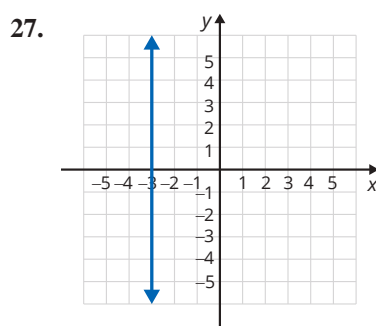
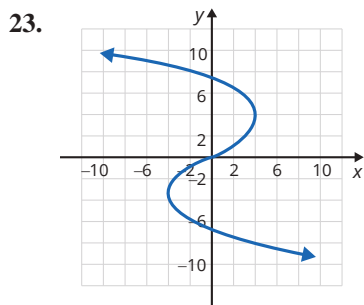
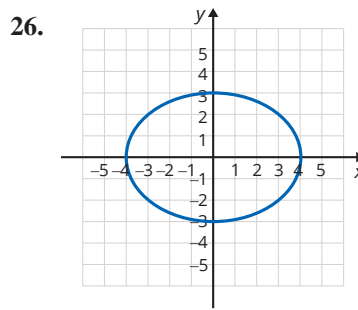
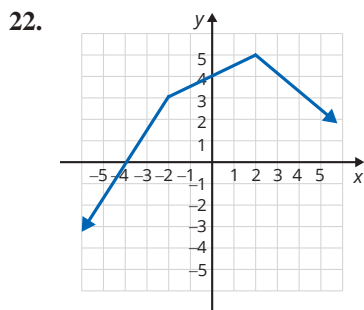
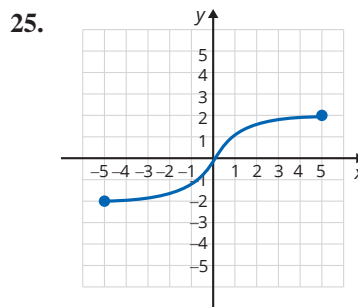
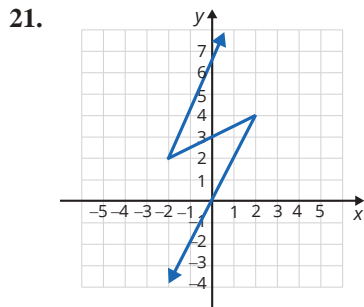
14. $t = \{(-1, -4), (0, -3), (2, -1), (4, 1), (1, 1)\}$

15. $f = \{(-1, 4), (-1, 2), (-1, 0), (-1, 6), (-1, -2)\}$

16. $g = \{(0, 0), (-2, -5), (2, 0), (4, -6), (5, 2)\}$

Use the vertical line test to determine whether or not each graph represents a function. State the domain and range using interval notation. See Example 4.





Express the function as a set of ordered pairs for the given equation and given domain. (**Hint:** Substitute each domain element for x and find the corresponding y -coordinate.)

29. $y = 3x + 1; D = \left\{-9, -\frac{1}{3}, 0, \frac{4}{3}, 2\right\}$

31. $y = 1 - 3x^2; D = \{-2, -1, 0, 1, 2\}$

30. $y = -\frac{3}{4}x + 2; D = \{-4, -2, 0, 3, 4\}$

32. $y = x^3 - 4x; D = \left\{-1, 0, \frac{1}{2}, 1, 2\right\}$

State the domains of the functions. See Example 5.

33. $y = -5x + 10$

35. $g(x) = \frac{8}{x}$

34. $2x + y = 14$

36. $h(x) = \frac{7}{3x}$

37. $y = \frac{13x^2 - 5x + 8}{x - 3}$

38. $f(x) = \frac{35}{x - 6}$

Find the values of the functions as indicated. See Examples 6 and 7.

39. $f(x) = 3x - 10$

a. $f(2)$

b. $f(-2)$

c. $f(0)$

40. $g(x) = -4x + 7$

a. $g(-3)$

b. $g(6)$

c. $g(0)$

41. $G(x) = x^2 + 5x + 6$

a. $G(-2)$

b. $G(1)$

c. $G(5)$

42. $F(x) = 6x^2 - 10$

a. $F(0)$

b. $F(-4)$

c. $F(4)$

43. $h(x) = x^3 - 8x$

a. $h(-3)$

b. $h(0)$

c. $h(3)$

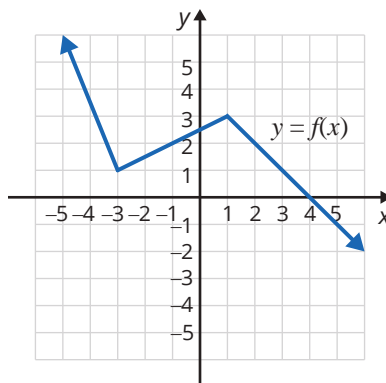
44. $P(x) = x^2 + 4x + 4$

a. $P(-2)$

b. $P(10)$

c. $P(-5)$

Using the graph of $f(x)$, find each value. See Example 8.




45. $f(1)$

46. $f(-3)$

47. $f(4)$

48. $f(-1)$

 Use a graphing calculator to graph the functions. Use the CALC features to find x -intercepts, if any. (The value of y will be 0 at those points.) For absolute value functions, select the MATH menu, then the NUM menu, and then abs (. Remember to press) after entering the absolute value. See Example 9.

49. $y = 6$

50. $y = 4x$

51. $y = x + 5$

52. $y = -2x + 3$

53. $y = x^2 - 4x$

54. $y = 1 + 2x - x^2$

55. $y = -|3x|$


56. $y = |x+2|$

57. $y = |x^2 - 3x|$

58. $y = 2x^3 - 5x^2 + 1$

59. $y = -x^3 + 3x - 1$

60. $y = x^4 - 10x^2 + 9$

 Use the CALC features of the calculator to find the coordinates of any points of intersection of the graphs. (**Hint:** The intersect item on the CALC menu will help in finding the point (or points) of intersection of two functions, if there is one.) In the Y = menu use both Y1 = and Y2 = to be able to graph both functions at the same time.

61. $y = 3x + 2$
 $y = 4 - x$

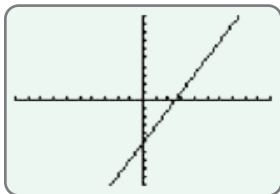
63. $y = 2x - 1$
 $y = x^2$

62. $y = 2 - x$
 $y = x$

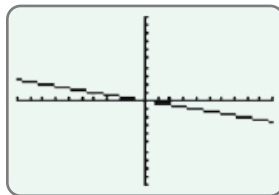
64. $y = x + 3$
 $y = -x^2 + x + 7$

The calculator display shows an incorrect graph for the corresponding equation. Explain how you know, by just looking at the graph, that a mistake has been made.

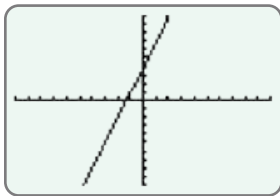
65. $y = 2x + 5$



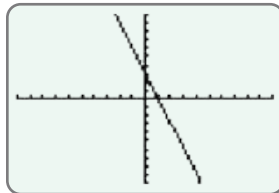
68. $y = -4x$



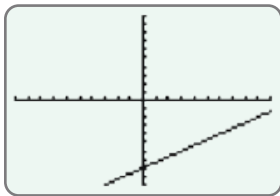
66. $y = -3x + 4$



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



67. $y = \frac{2}{3}x - 2$




Applications

Solve.

- 70.** A nurse hangs a 1000-milliliter IV bag that is set to drip at 120 milliliters per hour. Create a model of this situation to represent the amount of IV solution left in the bag after x hours.
- The y -intercept is the amount of IV solution in the bag initially (time = 0). What is the y -intercept?
 - The slope is equal to the rate that the IV solution is dispensed per hour. What is the slope? (**Hint:** Consider whether the amount of IV solution in the bag is increasing or decreasing and how this would affect the slope.)
 - Write an equation in slope-intercept form to model this situation.
 - Write the equation from part c. using function notation.
 - State the domain and range of the function.
 - State any additional restrictions that should be made on the domain for it to make sense in the context of this problem.
 - How much IV solution is left in the bag after 5 hours?
- 71.** Ariella is a full-time sales associate at a clothing store. She earns a weekly salary of \$250 and earns 15% commission on all of her sales. Create a model of this situation to represent the amount of money Ariella makes after x dollars in sales.
- What is the y -intercept and what does the y -coordinate of the y -intercept represent?
 - What is the slope and what does this value represent?
 - Write an equation in slope-intercept form to model this situation using the answers from parts a. and b.
 - Write the equation from part c. using function notation.
 - State the domain and range of the function.
 - State any additional restrictions that should be made on the domain for it to make sense in the context of this problem.
 - How much will Ariella make if she sells \$5000 worth of merchandise?

Writing & Thinking

- 72.**  Enter a variety of functions in your calculator, investigate your findings, and report these to your class. Certainly, interesting discussions will follow!