nebula was from the Milky Way galaxy and the nebula's velocity with respect to the Milky Way. The data are given in the following table. Distance is measured in megaparsecs (1 megaparsec equals 1.918×10^{19} miles), and velocity (called the *recession velocity*) is measured in kilometers per second. A negative velocity means the nebula is moving toward the Milky Way; a positive velocity means the nebula is moving away from the Milky Way.

Recession Velocities

Distance	Velocity	Distance	Velocity
0.032	170	0.9	650
0.034	290	0.9	150
0.214	−130	0.9	500
0.263	−70	1.0	920

Distance	Velocity	Distance	Velocity
0.275	−185	1.1	450
0.275	−220	1.1	500
0.45	200	1.4	500
0.5	290	1.7	960
0.5	270	2.0	500
0.63	200	2.0	850
0.8	300	2.0	800
0.9	−30	2.0	1090

a. Find the linear regression model for these data.

b. On the basis of this model, what is the recession velocity of a nebula that is 1.5 megaparsecs from the Milky Way?

Scan the following QR code to access WolframAlpha on a mobile device.

www.wolframalpha.com

Note

WolframAlpha is not just an online computational engine. It is also a knowledge engine. This means that in addition to performing mathematical procedures, it can provide answers to many questions that pertain to factual information.

WolframAlpha is different from most online search engines in that it finds answers to questions by searching through its very large database of factual information, rather than searching the Web for sites that might have information related to your question.

Apple's voice-powered iPhone assistant Siri (Speech Interpretation and Recognition Interface) often relies on WolframAlpha to answer questions that require factual information.

Sources: Wikipedia and CNET.

Exploring Concepts with Technology

Use WolframAlpha to Determine Linear and Quadratic Regressions

The online computational knowledge engine WolframAlpha, available at www.wolframalpha.com, can be used to determine linear and quadratic regression functions for a data set. WolframAlpha was conceived by British scientist Stephen Wolfram and developed by Wolfram Research. WolframAlpha runs on computers, tablets, and smartphones, although entering the necessary input data on a smartphone is a tedious process.

To find the linear regression function for the data set

$$S = \{(1, 2), (2, 3), (3, 3), (4, 4), (5, 7)\},$$

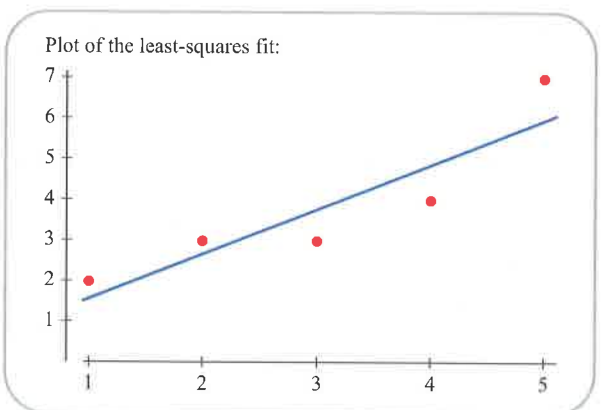
enter the following text into WolframAlpha's input field.

```
linear fit {(1, 2), (2, 3), (3, 3), (4, 4), (5, 7)}
```

Click on the equal sign icon, at the far right of the input field, to display

$$P(x) = 1.1x + 0.5$$

as the linear regression function. A graph of the linear regression function and a scatter plot of the data are also provided, as shown below.



(continued)

To determine the quadratic regression function for a data set, type "quadratic fit" followed by the data set.

You can learn about other procedures that can be performed by WolframAlpha by clicking on the "Examples" link that appears under the yellow input field.

CHAPTER 2 TEST PREP

The following test prep table summarizes essential concepts in this chapter. The references given in the right-hand column list Examples and Exercises that can be used to test your understanding of a concept.

2.1 Two-Dimensional Coordinate System and Graphs

Distance Formula The distance d between two points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ is $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.	See Example 1, page 154, and then try Exercise 2, page 252.
Midpoint Formula The coordinates of the midpoint of the line segment from $P_1(x_1, y_1)$ to $P_2(x_2, y_2)$ are $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$.	See Example 1, page 154, and then try Exercise 4, page 252.
Graph of an Equation The graph of an equation in the two variables x and y is the graph of all ordered pairs that satisfy the equation.	See Examples 2 and 3, pages 155 and 156, and then try Exercise 7, page 252.
***x*-Intercepts and *y*-Intercepts** If $(x_1, 0)$ satisfies an equation in two variables, then the point $P(x_1, 0)$ is an x-intercept of the graph of the equation. If $(0, y_1)$ satisfies an equation in two variables, then the point $P(0, y_1)$ is a y-intercept of the graph of the equation.	See Example 5, page 158, and then try Exercise 9, page 252.
Equation of a Circle The standard form of the equation of a circle with center (h, k) and radius r is $(x - h)^2 + (y - k)^2 = r^2$.	See Examples 6 and 7, pages 160 and 161, and then try Exercises 14 and 16, page 252.

2.2 Introduction to Functions

Definition of a Function A function is a set of ordered pairs in which no two ordered pairs have the same first coordinate and different second coordinates.	See Example 1, page 166, and then try Exercises 18 and 20, page 252.
Evaluate a Function To evaluate a function, replace the independent variable with a number in the domain of the function and then simplify the resulting numerical expression.	See Example 2, page 166, and then try Exercise 22, page 252.
Piecewise-Defined Function A piecewise-defined function is represented by more than one expression.	See Example 3, page 167, and then try Exercise 23, page 252.
Domain and Range of a Function The domain of a function is the set of all first coordinates of the ordered pairs of the function. The range of a function is the set of all second coordinates of the ordered pairs of the function.	See Example 4, page 168, and then try Exercise 26, page 252. See Example 6, page 170, and then try Exercise 29, page 252.
Graph a Function The graph of a function is the graph of all ordered pairs of the function.	See Example 5, page 170, and then try Exercise 31, page 252.

Zero of a Function A value a in the domain of a function f for which $f(a) = 0$ is called a zero of the function.	See Example 7, page 172, and then try Exercise 34, page 252.
Greatest Integer Function (Floor Function) The value of the greatest integer function at the real number x is the greatest integer that is less than or equal to x.	See Example 9, page 176, and then try Exercise 36, page 252.

2.3 Linear Functions

Slope of a Line If $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ are two points on a line, then the slope m of the line between the two points is given by $m = \dfrac{y_2 - y_1}{x_2 - x_1}$, $x_1 \neq x_2$. If $x_1 = x_2$, the line is vertical and the slope is undefined.	See Example 1, page 185, and then try Exercise 40, page 253.
Slope–Intercept Form of the Equation of a Line The equation $f(x) = mx + b$ is called the slope–intercept form of a linear function because the graph of the function is a straight line. The slope is m, and the y-intercept is $(0, b)$.	See Example 2, page 187, and then try Exercise 42, page 253.
General Form of a Linear Equation in Two Variables An equation of the form $Ax + By = C$, where A, B, and C are real numbers and both A and B are not zero, is called the general form of a linear equation in two variables.	See Example 3, page 187, and then try Exercise 43, page 253.
Point–Slope Form The equation $y - y_1 = m(x - x_1)$ is called the point–slope form of the equation of a line. This equation is frequently used to find the equation of a line.	See Examples 4 and 5, pages 188 and 189, and then try Exercises 45 and 48, page 253.
Parallel Lines If m_1 and m_2 are the slopes of two lines in the plane, then the graphs of the lines are parallel if and only if $m_1 = m_2$. That is, parallel lines have the same slope. Vertical lines are parallel.	See Example 6a, page 190, and then try Exercise 50, page 253.
Perpendicular Lines If m_1 and m_2 are the slopes of two lines in the plane, then the graphs of the lines are perpendicular if and only if $m_1 = -\dfrac{1}{m_2}$. That is, the slopes of perpendicular lines are negative reciprocals of each other. A vertical line is perpendicular to a horizontal line.	See Example 6b, page 190, and then try Exercise 52, page 253.
Applications	See Example 7, page 190, and then try Exercise 53, page 253.

2.4 Quadratic Functions

Quadratic Function A quadratic function f can be represented by the equation $f(x) = ax^2 + bx + c$, where a, b, and c are real numbers and $a \neq 0$. Every quadratic function given by $f(x) = ax^2 + bx + c$, $a \neq 0$, can be written in standard form as $f(x) = a(x - h)^2 + k$. The graph of f is a parabola with vertex (h, k).	See Example 1, page 199, and then try Exercise 56, page 253.

(continued)

Parabola The graph of a quadratic function given by $f(x) = ax^2 + bx + c$, $a \neq 0$ is a parabola. The coordinates of the vertex of the parabola are $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$. The equation of the axis of symmetry is $x = -\frac{b}{2a}$. The parabola opens up when $a > 0$ and opens down when $a < 0$.	See Example 2, page 201, and then try Exercise 61, page 253.
Minimum or Maximum of a Quadratic Function If $a > 0$, then the graph of $f(x) = ax^2 + bx + c$ opens up and the vertex $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$ is the lowest point on the graph; $f\left(-\frac{b}{2a}\right)$ is the minimum value of the function. If $a < 0$, then the graph of $f(x) = ax^2 + bx + c$ opens down and the vertex $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$ is the highest point on the graph; $f\left(-\frac{b}{2a}\right)$ is the maximum value of the function.	See Example 4, page 202, and then try Exercise 66, page 253.
Applications of Quadratic Functions	See Examples 5 through 8, pages 203–205, and then try Exercises 67 through 69, pages 253 and 254.

2.5 Properties of Graphs

Symmetry of a Graph with Respect to • **the x-axis** The graph of an equation is symmetric with respect to the x-axis if the replacement of y with $-y$ leaves the equation unaltered. • **the y-axis** The graph of an equation is symmetric with respect to the y-axis if the replacement of x with $-x$ leaves the equation unaltered. • **the origin** The graph of an equation is symmetric with respect to the origin if the replacement of x with $-x$ and the replacement of y with $-y$ leaves the equation unaltered.	See Examples 1 and 2, pages 211 and 212, and then try Exercises 72, 73, and 77, page 254.
Even and Odd Functions The function f is an even function if $f(-x) = f(x)$ for all x in the domain of the function. The function f is an odd function if $f(-x) = -f(x)$ for all x in the domain of the function.	See Example 3, page 213, and then try Exercises 80 and 84, page 254.
Vertical Translation of a Graph If f is a function and c is a positive constant, then the graph of • $y = f(x) + c$ is a vertical shift c units upward of the graph of $y = f(x)$. • $y = f(x) - c$ is a vertical shift c units downward of the graph of $y = f(x)$.	See Example 4, page 215, and then try Exercise 86, page 254.
Horizontal Translation of a Graph If f is a function and c is a positive constant, then the graph of • $y = f(x + c)$ is a horizontal shift c units to the left of the graph of $y = f(x)$. • $y = f(x - c)$ is a horizontal shift c units to the right of the graph of $y = f(x)$.	See Examples 5 and 6, pages 215 and 216, and then try Exercises 87 and 88, page 254.

Reflections of a Graph The graph of • $y = -f(x)$ is the graph of $y = f(x)$ reflected across the x-axis. • $y = f(-x)$ is the graph of $y = f(x)$ reflected across the y-axis.	See Example 7, page 217, and then try Exercises 90 and 91, page 254.
Vertical Stretching and Compressing of a Graph Assume that f is a function and c is a positive constant. Then • if $c > 1$, the graph of $y = c \cdot f(x)$ is the graph of $y = f(x)$ stretched vertically away from the x-axis by a factor of c. • if $0 < c < 1$, the graph of $y = c \cdot f(x)$ is the graph of $y = f(x)$ compressed vertically toward the x-axis by a factor of c.	See Example 8, page 219, and then try Exercise 92, page 254.
Horizontal Stretching and Compressing of a Graph Assume that f is a function and c is a positive constant. Then • if $c > 1$, the graph of $y = f(c \cdot x)$ is the graph of $y = f(x)$ compressed horizontally toward the y-axis by a factor of $\frac{1}{c}$. • if $0 < c < 1$, the graph of $y = f(c \cdot x)$ is the graph of $y = f(x)$ stretched horizontally away from the y-axis by a factor of $\frac{1}{c}$.	See Example 9, page 220, and then try Exercise 95, page 254.

2.6 Algebra of Functions

Operations on Functions If f and g are functions with domains D_f and D_g, then • $(f + g)(x) = f(x) + g(x)$ Domain: $D_f \cap D_g$ • $(f - g)(x) = f(x) - g(x)$ Domain: $D_f \cap D_g$ • $(f \cdot g)(x) = f(x) \cdot g(x)$ Domain: $D_f \cap D_g$ • $\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)}$ Domain: $D_f \cap D_g$, $g(x) \neq 0$	See Example 2, page 227, and then try Exercise 96, page 254.
Difference Quotient For a given function f, the expression $\frac{f(x+h) - f(x)}{h}$, $h \neq 0$, is called the difference quotient.	See Examples 3 and 4, pages 228 and 229, and then try Exercises 97 and 99, page 254.
Composition of Functions Let f and g be two functions such that $g(x)$ is in the domain of f for all x in the domain of g. Then the composition of the two functions, denoted by $f \circ g$, is the function whose value at x is given by $(f \circ g)(x) = f[g(x)]$.	See Examples 5 and 6, pages 231 and 232, and then try Exercises 100 and 101, page 254.

2.7 Modeling Data Using Regression

Linear Regression Linear regression is a method of fitting a linear function to data.	See Example 1, page 239, and then try Exercise 102, page 255.
Quadratic Regression Quadratic regression is a method of fitting a quadratic function to data.	See Example 2, page 241, and then try Exercise 103, page 255.

CHAPTER 2 REVIEW EXERCISES

In Exercises 1 and 2, find the distance between the points whose coordinates are given.

1. $(-3, 2)$ $(7, 11)$ **2.** $(5, -4)$ $(-3, -8)$

In Exercises 3 and 4, find the midpoint of the line segment with the given endpoints.

3. $(2, 8)$ $(-3, 12)$ **4.** $(-4, 7)$ $(8, -11)$

In Exercises 5 to 8, graph each equation by plotting points.

5. $2x - y = -2$ **6.** $2x^2 + y = 4$

7. $y = |x - 2| + 1$ **8.** $y = -|2x|$

In Exercises 9 to 12, find the *x*- and *y*-intercepts of the graph of each equation. Use the intercepts and some additional points as needed to draw the graph of the equation.

9. $x = y^2 - 1$ **10.** $|x - y| = 4$

11. $3x + 4y = 12$ **12.** $x = |y - 1| + 1$

In Exercises 13 and 14, determine the center and radius of the circle with the given equation.

13. $(x - 3)^2 + (y + 4)^2 = 81$

14. $x^2 + y^2 + 10x + 4y + 20 = 0$

In Exercises 15 and 16, find the equation in standard form of the circle that satisfies the given conditions.

15. Center $C = (2, -3)$, radius $r = 5$

16. Center $C = (-5, 1)$, passing through $(3, 1)$

In Exercises 17 to 20, determine whether the equation defines *y* as a function of *x*.

17. $x - y = 4$ **18.** $x + y^2 = 4$

19. $|x| + |y| = 4$ **20.** $|x| + y = 4$

21. If $f(x) = 3x^2 + 4x - 5$, find
a. $f(1)$ **b.** $f(-3)$
c. $f(t)$ **d.** $f(x + h)$
e. $3f(t)$ **f.** $f(3t)$

22. If $g(x) = \sqrt{64 - x^2}$, find
a. $g(3)$ **b.** $g(-5)$
c. $g(8)$ **d.** $g(-x)$
e. $2g(t)$ **f.** $g(2t)$

23. Let f be a piecewise-defined function given by

$$f(x) = \begin{cases} 3x + 2, & x < 0 \\ x^2 - 3, & x \geq 0 \end{cases}$$

Find each of the following.
a. $f(3)$ **b.** $f(-2)$ **c.** $f(0)$

24. Let f be a piecewise-defined function given by

$$f(x) = \begin{cases} x + 4, & x < -3 \\ x^2 + 1, & -3 \leq x < 5 \\ x - 7, & x \geq 5 \end{cases}$$

Find each of the following.
a. $f(0)$ **b.** $f(-3)$ **c.** $f(5)$

In Exercises 25 to 28, determine the domain of the function represented by the given equation.

25. $f(x) = -2x^2 + 3$ **26.** $f(x) = \sqrt{6 - x}$

27. $f(x) = \sqrt{25 - x^2}$ **28.** $f(x) = \dfrac{3}{x^2 - 2x - 15}$

29. Find the values of a in the domain of $f(x) = x^2 + 2x - 4$ for which $f(a) = -1$.

30. Find the value of a in the domain of $f(x) = \dfrac{4}{x + 1}$ for which $f(a) = 2$.

In Exercises 31 and 32, graph the given equation.

31. $f(x) = |x - 1| - 1$ **32.** $f(x) = 4 - \sqrt{x}$

In Exercises 33 and 34, find the zero or zeros of the given function.

33. $f(x) = 2x + 6$ **34.** $f(x) = x^2 - 4x - 12$

In Exercises 35 and 36, find each function value.

35. Let $g(x) = [\![2x]\!]$.
a. $g(\pi)$ **b.** $g\left(-\dfrac{2}{3}\right)$ **c.** $g(-2)$

36. Let $f(x) = [\![1 - x]\!]$.
a. $f(\sqrt{2})$ **b.** $f(0.5)$ **c.** $f(-\pi)$

In Exercises 37 to 40, find the slope of the line between the points with the given coordinates.

37. $(-3, 6); (4, -1)$

38. $(-5, 2); (-5, 4)$

39. $(4, -2); (-3, -2)$

40. $(6, -3); (-4, -1)$

41. Graph $f(x) = -\frac{3}{4}x + 2$ using the slope and y-intercept.

42. Graph $f(x) = 2 - x$ using the slope and y-intercept.

43. Graph $3x - 4y = 8$.

44. Graph $2x + 3y = 9$.

45. Find the equation of the line that passes through the point with coordinates $(-3, 2)$ and whose slope is $-\frac{2}{3}$.

46. Find the equation of the line that passes through the point with coordinates $(1, -4)$ and whose slope is -2.

47. Find the equation of the line that passes through the points with coordinates $(-2, 3)$ and $(1, 6)$.

48. Find the equation of the line that passes through the points with coordinates $(-4, -6)$ and $(8, 15)$.

49. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(3, -5)$ and is parallel to the graph of $y = \frac{2}{3}x - 1$.

50. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(-1, -5)$ and is parallel to the graph of $2x - 5y = 2$.

51. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(3, -1)$ and is perpendicular to the graph of $y = -\frac{3}{2}x - 2$.

52. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(2, 6)$ and is perpendicular to the graph of $2x - 5y = 10$.

53. Sports The speed of a professional golfer's swing and the speed of the ball as it leaves the club are important factors in the distance the golf ball travels. The table below shows five measurements of clubhead speed and ball speed, each in miles per hour.

Measurement	Clubhead Speed (mph)	Ball Speed (mph)
1	106	155
2	108	159
3	114	165
4	116	171
5	118	175

Use measurements 1 and 5 to find a linear function that could be used to determine ball speed for a given clubhead speed.

54. Food Science Newer heating elements allow an oven to reach a normal baking temperature (350°F) more quickly. The table below shows the time, in minutes, since an oven was turned on and the temperature of the oven.

Measurement	Time (min)	Temperature (°F)
1	0	75
2	2	122
3	4	182
4	6	255
5	8	300
6	10	350

Use measurements 2 and 6 to find a linear function that could be used to determine the temperature of the oven as a function of time.

In Exercises 55 to 60, use the method of completing the square to write each quadratic equation in its standard form.

55. $f(x) = x^2 + 6x + 10$

56. $f(x) = 2x^2 + 4x + 5$

57. $f(x) = -x^2 - 8x + 3$

58. $f(x) = 4x^2 - 6x + 1$

59. $f(x) = -3x^2 + 4x - 5$

60. $f(x) = x^2 - 6x + 9$

In Exercises 61 to 64, find the vertex of the graph of the quadratic function.

61. $f(x) = 3x^2 - 6x + 11$

62. $h(x) = 4x^2 - 10$

63. $k(x) = -6x^2 + 60x + 11$

64. $m(x) = 14 - 8x - x^2$

In Exercises 65 and 66, find the requested value.

65. The maximum value of $f(x) = -x^2 + 6x - 3$

66. The minimum value of $g(x) = 2x^2 + 3x - 4$

67. Height of a Ball A ball is thrown vertically upward with an initial velocity of 50 feet per second. The height h, in feet, of the ball t seconds after it is released is given by the equation $h(t) = -16t^2 + 50t + 4$. What is the maximum height reached by the ball?

68. Delivery Cost A freight company has determined that its cost, in dollars, per delivery of x parcels is

$$C(x) = 1050 + 0.5x$$

The price it charges to send a parcel is \$13.00 per parcel. Determine

a. the revenue function

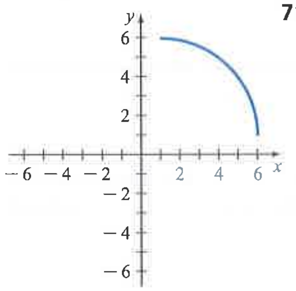
b. the profit function

c. the minimum number of parcels the company must ship to break even

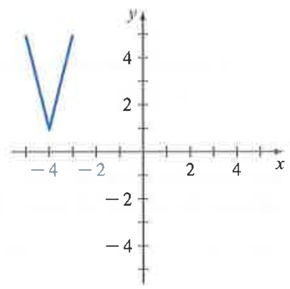
69. **Agriculture** A farmer wishes to enclose a rectangular region bordering a river using 700 feet of fencing. What is the maximum area that can be enclosed with the fencing?

In Exercises 70 and 71, sketch a graph that is symmetric to the given graph with respect to the a. x-axis, b. y-axis, and c. origin.

70.



71.



In Exercises 72 to 79, determine whether the graph of each equation is symmetric with respect to the a. x-axis, b. y-axis, and c. origin.

72. $y = x^2 - 7$

73. $x = y^2 + 3$

74. $y = x^3 - 4x$

75. $y^2 = x^2 + 4$

76. $\frac{x^2}{3^2} + \frac{y^2}{4^2} = 1$

77. $xy = 8$

78. $|y| = |x|$

79. $|x + y| = 4$

In Exercises 80 to 85, sketch the graph of g. a. Find the domain and the range of g. b. State whether g is even, odd, or neither.

80. $g(x) = -x^2 + 4$

81. $g(x) = -2x - 4$

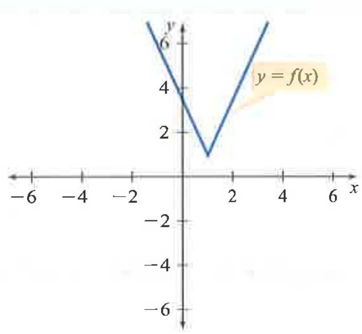
82. $g(x) = |x - 2| + |x + 2|$

83. $g(x) = \sqrt{16 - x^2}$

84. $g(x) = x^3 - x$

85. $g(x) = 2[\![x]\!]$

In Exercises 86 to 91, use the graph of f shown below to sketch a graph of g.



86. $g(x) = f(x) - 2$

87. $g(x) = f(x + 3)$

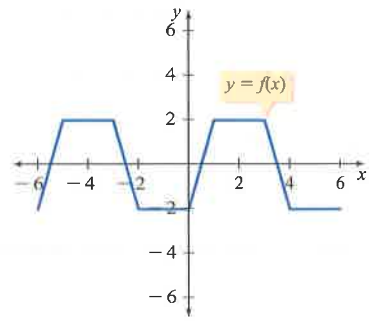
88. $g(x) = f(x - 1) - 3$

89. $g(x) = f(x + 2) - 1$

90. $g(x) = f(-x)$

91. $g(x) = -f(x)$

In Exercises 92 to 95, use the graph of f shown below to sketch a graph of g.



92. $g(x) = 2f(x)$

93. $g(x) = \frac{1}{2}f(x)$

94. $g(x) = f(2x)$

95. $g(x) = f\left(\frac{1}{2}x\right)$

96. Let $f(x) = x^2 + x - 2$ and $g(x) = 3x + 1$. Find each of the following.

a. $(f + g)(2)$

b. $\left(\frac{f}{g}\right)(-1)$

c. $(f - g)(x)$

d. $(f \cdot g)(x)$

97. If $f(x) = 4x^2 - 3x - 1$, find the difference quotient

$$\frac{f(x + h) - f(x)}{h}$$

98. If $g(x) = x^3 - x$, find the difference quotient

$$\frac{g(x + h) - g(x)}{h}$$

99. **Ball Rolling on a Ramp** The distance traveled by a ball rolling down a ramp is given by $s(t) = 3t^2$, where t is the time in seconds after the ball is released and $s(t)$ is measured in feet. Evaluate the average velocity of the ball for each of the following time intervals.

a. [2, 4] **b.** [2, 3] **c.** [2, 2.5] **d.** [2, 2.01]

e. What appears to be the average velocity of the ball for the time interval $[2, 2 + \Delta t]$ as Δt approaches 0?

100. If $f(x) = x^2 + 4x$ and $g(x) = x - 8$, find

a. $(f \circ g)(3)$

b. $(g \circ f)(-3)$

c. $(f \circ g)(x)$

d. $(g \circ f)(x)$

101. If $f(x) = 2x^2 + 7$ and $g(x) = |x - 1|$, find

a. $(f \circ g)(-5)$

b. $(g \circ f)(-5)$

c. $(f \circ g)(x)$

d. $(g \circ f)(x)$

102. **Sports** A soccer coach examined the relationship between the speed, in meters per second, of a soccer player's foot when it strikes the ball and the initial speed, in meters per second, of the ball. The table below shows the values obtained by the coach.

Foot Speed (m/s)	Initial Ball Speed (m/s)
5	12
8	13
11	18
14	22
17	26
20	28

a. Find a linear regression equation for these data.

b. Using the regression model, what is the expected initial speed of a ball that is struck with a foot speed of 12 meters per second? Round to the nearest meter per second.

103. **Physics** The rate at which water will escape from the bottom of a ruptured can depends on a number of factors, including the height of the water, the size of the hole, and the diameter of the can. The table below shows the height h (in millimeters) of water in a can after t seconds.

Water Escaping a Ruptured Can

Time (t)	Height (h)	Time (t)	Height (h)
180	0	93	60
163	10	81	70
147	20	70	80
133	30	60	90
118	40	50	100
105	50	48	110

a. Find the quadratic regression model for these data.

b. On the basis of this model, will the can ever empty?

c. Explain why there seems to be a contradiction between the model and reality, in that we know that the can will eventually run out of water.

CHAPTER 2 TEST

1. Find the midpoint and the length of the line segment with endpoints $(-2, 3)$ and $(4, -1)$.

2. Determine the x- and y-intercepts of the equation $x = 2y^2 - 4$. Then graph the equation.

3. Graph the equation $y = |x + 2| + 1$.

4. Find the center and radius of the circle that has the general form $x^2 - 4x + y^2 + 2y - 4 = 0$.

5. Determine the domain of the function
$$f(x) = -\sqrt{x^2 - 16}$$

6. Find the elements a in the domain of $f(x) = x^2 + 6x - 17$ for which $f(a) = -1$.

7. Find the slope of the line that passes through the points with coordinates $(5, -2)$ and $(-1, 3)$.

8. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(5, -3)$ and whose slope is -2.

9. Find the slope–intercept form of the equation of the line that passes through the point with coordinates $(4, -2)$ and is perpendicular to the graph of $3x - 2y = 4$.

10. Write the equation of the parabola $f(x) = x^2 + 6x - 2$ in standard form. What are the coordinates of the vertex, and what is the equation of the axis of symmetry?

11. Find the maximum or minimum value of the function $f(x) = x^2 - 4x - 8$. State whether this value is a maximum or a minimum.

12. Classify each of the following as an even function, an odd function, or neither.

a. $f(x) = x^4 - x^2$

b. $f(x) = x^3 - x$

c. $f(x) = x - 1$

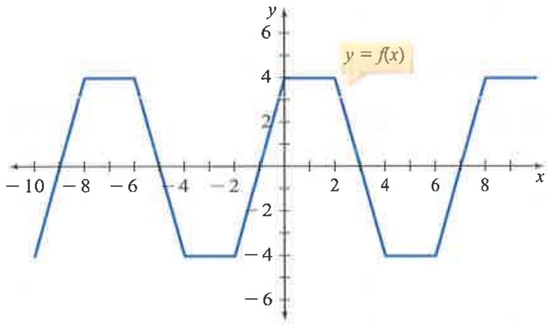
13. Classify the graph of each equation as being symmetric with respect to the x-axis, the y-axis, or the origin.

a. $y^2 = x + 1$

b. $y = 2x^3 + 3x$

c. $y = 3x^2 - 2$

In Exercises 14 to 18, sketch the graph of *g* given the graph of *f* below.



14. $g(x) = 2f(x)$ **15.** $g(x) = f\left(\frac{1}{2}x\right)$

16. $g(x) = -f(x)$ **17.** $g(x) = f(x-1) + 3$

18. $g(x) = f(-x)$

19. Let $f(x) = x^2 - x + 2$ and $g(x) = 2x - 1$. Find

a. $(f - g)(x)$ **b.** $(f \cdot g)(-2)$

c. $(f \circ g)(3)$ **d.** $(g \circ f)(x)$

20. Find the difference quotient of the function $f(x) = x^2 + 1$.

21. **Dog Run** A homeowner has 80 feet of fencing to make a rectangular dog run alongside a house as shown below.

What dimensions x and y of the rectangle will produce the maximum area?

22. **Ball Rolling on a Ramp** The distance traveled by a ball rolling down a ramp is given by $s(t) = 5t^2$, where t is the time in seconds after the ball is released and $s(t)$ is measured in feet. Evaluate the average velocity of the ball for each of the following time intervals.

a. [2, 3]

b. [2, 2.5]

c. [2, 2.01]

23. **Calorie Content** The label on the can below shows the percentage of water and the number of calories in various canned soups to which 100 grams of water are added.

a. Find the equation of the linear regression line for these data.

b. Using the linear model from part **a.**, find the expected number of calories in a soup that is 89% water. Round to the nearest calorie.

CUMULATIVE REVIEW EXERCISES

1. What property of real numbers is demonstrated by the equation $3(a + b) = 3(b + a)$?

2. Which of the numbers -3, $-\frac{2}{3}$, $\frac{6}{\pi}$, 0, $\sqrt{16}$, and $\sqrt{2}$ are not rational numbers?

In Exercises 3 to 8, simplify the expression.

3. $3 + 4(2x - 9)$

4. $(-4xy^2)^3(-2x^2y^4)$

5. $\frac{24a^4b^3}{18a^4b^5}$

6. $(2x + 3)(3x - 7)$

7. $\frac{x^2 + 6x - 27}{x^2 - 9}$

8. $\frac{4}{2x - 1} - \frac{2}{x - 1}$

In Exercises 9 to 14, solve for *x*.

9. $6 - 2(2x - 4) = 14$

10. $x^2 - x - 1 = 0$

11. $(2x - 1)(x + 3) = 4$

12. $3x + 2y = 15$

13. $x^4 - x^2 - 2 = 0$

14. $3x - 1 < 5x + 7$

15. Find the distance between the points $P_1(-2, -4)$ and $P_2(2, -3)$.

16. Given $G(x) = 2x^3 - 4x - 7$, find $G(-2)$.

17. Find the equation of the line that passes through the points $P_1(2, -3)$ and $P_2(-2, -1)$.

18. **Chemistry** How many ounces of pure water must be added to 60 ounces of an 8% salt solution to make a 3% salt solution?

19. **Tennis** The path of a tennis ball during a serve is given by $h(x) = -0.002x^2 - 0.03x + 8$, where $h(x)$ is the height of the ball in feet x feet from the server. For a serve to be legal in tennis, the ball must be at least 3 feet high when it is 39 feet from the server, and it must land in a spot that is less than 60 feet from the server. Does the path of the ball satisfy the conditions of a legal serve?

20. **Medicine** A patient with a fever is given a medication to reduce the fever. The equation $T = -0.04t + 104$ models the patient's temperature T, in degrees Fahrenheit, t minutes after taking the medication. What is the rate, in degrees Fahrenheit per minute, at which the patient's temperature is decreasing?