Answers to 5–12, 31, 32, 41–44, 70, 71, and 80–95 are on pages AA9–AA11.

CHAPTER 2 REVIEW EXERCISES

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

1. $(-3, 2)$ $(7, 11)$ $\sqrt{181}$ [2.1]
2. $(5, -4)$ $(-3, -8)$ $\sqrt{80} = 4\sqrt{5}$ [2.1]

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

3. $(2, 8)$ $(-3, 12)$ $\left(-\frac{1}{2}, 10\right)$ [2.1]
4. $(-4, 7)$ $(8, -11)$ $(2, -2)$ [2.1]

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

5. $2x - y = -2$ [2.1]
6. $2x^2 + y = 4$ [2.1]
7. $y = |x - 2| + 1$ [2.1]
8. $y = -|2x|$ [2.1]

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. $x = y^2 - 1$ [2.1]
10. $|x - y| = 4$ [2.1]
11. $3x + 4y = 12$ [2.1]
12. $x = |y - 1| + 1$ [2.1]

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

13. $(x - 3)^2 + (y + 4)^2 = 81$ Center $(3, -4)$, radius 9 [2.1]
14. $x^2 + y^2 + 10x + 4y + 20 = 0$ Center $(-5, -2)$, radius 3 [2.1]

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 $r = 5$
    $(x - 2)^2 + (y + 3)^2 = 5^2$ [2.1]
16. Center $C = (-5, 1)$, passing through $(3, 1)$
    $(x + 5)^2 + (y - 1)^2 = 8^2$ [2.1]

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

17. $x - y = 4$ Yes [2.2]
18. $x + y^2 = 4$ No [2.2]
19. $|x| + |y| = 4$ No [2.2]
20. $|x| + y = 4$ Yes [2.2]

21. If $f(x) = 3x^2 + 4x - 5$, find
    a. $f(1)$ 2
    b. $f(-3)$ 10
    c. $f(t)$ $3t^2 + 4t - 5$
    d. $f(x + h)$ $3x^2 + 6xh + 3h^2 + 4x + 4h - 5$
    e. $3f(t)$ $9t^2 + 12t - 15$
    f. $f(3t)$ $27t^2 + 12t - 5$ [2.2]

22. If $g(x) = \sqrt{64 - x^2}$, find
    a. $g(3)$ $\sqrt{55}$
    b. $g(-5)$ $\sqrt{39}$
    c. $g(8)$ 0
    d. $g(-x)$ $\sqrt{64 - x^2}$
    e. $2g(t)$ $2\sqrt{64 - t^2}$
    f. $g(2t)$ $2\sqrt{16 - t^2}$ [2.2]

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. $f(3)$ 6
    b. $f(-2)$ -4
    c. $f(0)$ -3 [2.2]

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. $f(0)$ 1
    b. $f(-3)$ 10
    c. $f(5)$ -2 [2.2]

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

25. $f(x) = -2x^2 + 3$
    Domain: $\{x | x$ is a real number$\}$ [2.2]
26. $f(x) = \sqrt{6 - x}$
    Domain: $\{x | x \leq 6\}$ [2.2]
27. $f(x) = \sqrt{25 - x^2}$
    Domain: $\{x | -5 \leq x \leq 5\}$ [2.2]
28. $f(x) = \dfrac{3}{x^2 - 2x - 15}$
    Domain: $\{x | x \neq -3, x \neq 5\}$ [2.2]

29. Find the values of a in the domain of $f(x) = x^2 + 2x - 4$ for which $f(a) = -1$. -3 and 1 [2.2]

30. Find the value of a in the domain of $f(x) = \dfrac{4}{x + 1}$ for which $f(a) = 2$. 1 [2.2]

In Exercises 31 and 32, graph the given equation.

31. $f(x) = |x - 1| - 1$ [2.2]
32. $f(x) = 4 - \sqrt{x}$ [2.2]

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

33. $f(x) = 2x + 6$ -3 [2.2]
34. $f(x) = x^2 - 4x - 12$ -2 and 6 [2.2]

In Exercises 35 and 36, find each function value.

35. Let $g(x) = [\![2x]\!]$.
    a. $g(\pi)$ 6
    b. $g\left(-\frac{2}{3}\right)$ -2
    c. $g(-2)$ -4 [2.2]

36. Let $f(x) = [\![1 - x]\!]$.
    a. $f(\sqrt{2})$ -1
    b. $f(0.5)$ 0
    c. $f(-\pi)$ 4 [2.2]

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

37. $(-3, 6); (4, -1)$ -1 [2.3]

38. $(-5, 2); (-5, 4)$ Undefined [2.3]

39. $(4, -2); (-3, -2)$ 0 [2.3]

40. $(6, -3); (-4, -1)$ $-\frac{1}{5}$ [2.3]

41. Graph $f(x) = -\frac{3}{4}x + 2$ using the slope and y-intercept. [2.3]

42. Graph $f(x) = 2 - x$ using the slope and y-intercept. [2.3]

43. Graph $3x - 4y = 8$. [2.3]

44. Graph $2x + 3y = 9$. [2.3]

45. Find the equation of the line that passes through the point with coordinates $(-3, 2)$ and whose slope is $-\frac{2}{3}$. $y = -\frac{2}{3}x$ [2.3]

46. Find the equation of the line that passes through the point with coordinates $(1, -4)$ and whose slope is -2. $y = -2x - 2$ [2.3]

47. Find the equation of the line that passes through the points with coordinates $(-2, 3)$ and $(1, 6)$. $y = x + 5$ [2.3]

48. Find the equation of the line that passes through the points with coordinates $(-4, -6)$ and $(8, 15)$. $y = \frac{7}{4}x + 1$ [2.3]

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 $y = \frac{2}{3}x - 1$. $y = \frac{2}{3}x - 7$ [2.3]

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 $2x - 5y = 2$. $y = \frac{2}{5}x - \frac{23}{5}$ [2.3]

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 $y = -\frac{3}{2}x - 2$. $y = \frac{2}{3}x - 3$ [2.3]

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 $2x - 5y = 10$. $y = -\frac{5}{2}x + 11$ [2.3]

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. $f(x) = \frac{5}{3}x - \frac{65}{3}$ [2.3]

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. $f(t) = 28.5t + 65$ [2.3]

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

55. $f(x) = x^2 + 6x + 10$ $f(x) = (x + 3)^2 + 1$ [2.4]

56. $f(x) = 2x^2 + 4x + 5$ $f(x) = 2(x + 1)^2 + 3$ [2.4]

57. $f(x) = -x^2 - 8x + 3$ $f(x) = -(x + 4)^2 + 19$ [2.4]

58. $f(x) = 4x^2 - 6x + 1$ $f(x) = 4\left(x - \frac{3}{4}\right)^2 - \frac{5}{4}$ [2.4]

59. $f(x) = -3x^2 + 4x - 5$ $f(x) = -3\left(x - \frac{2}{3}\right)^2 - \frac{11}{3}$ [2.4]

60. $f(x) = x^2 - 6x + 9$ $f(x) = (x - 3)^2 + 0$ [2.4]

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

61. $f(x) = 3x^2 - 6x + 11$ (1, 8) [2.4]

62. $h(x) = 4x^2 - 10$ (0, −10) [2.4]

63. $k(x) = -6x^2 + 60x + 11$ (5, 161) [2.4]

64. $m(x) = 14 - 8x - x^2$ (−4, 30) [2.4]

In Exercises 65 and 66, find the requested value.

65. The maximum value of $f(x) = -x^2 + 6x - 3$ 6 [2.4]

66. The minimum value of $g(x) = 2x^2 + 3x - 4$ −5.125 [2.4]

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? 43.0625 ft [2.4]

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 $R = 13x$

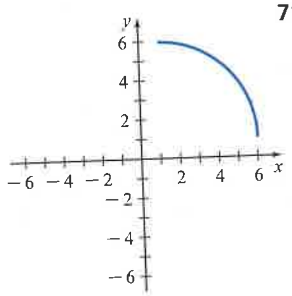
b. the profit function $P = 12.5x - 1050$

c. the minimum number of parcels the company must ship to break even 84 parcels [2.3]

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?
61,250 ft^2 [2.4]

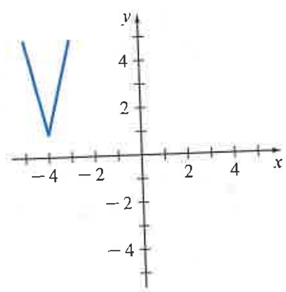
In Exercises 70 and 71, sketch a graph that is symmetric to the given graph with respect to the a. *x*-axis, b. *y*-axis, and c. origin.

70.



[2.5]

71.



[2.5]

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. $y = x^2 - 7$
Symmetric to the y-axis [2.5]

73. $x = y^2 + 3$
Symmetric to the x-axis [2.5]

74. $y = x^3 - 4x$
Symmetric to the origin [2.5]

75. $y^2 = x^2 + 4$
Symmetric to the x-axis, the y-axis, and the origin [2.5]

76. $\dfrac{x^2}{3^2} + \dfrac{y^2}{4^2} = 1$ Symmetric to the x-axis, the y-axis, and the origin [2.5]

77. $xy = 8$
Symmetric to the origin [2.5]

78. $|y| = |x|$
Symmetric to the x-axis, the y-axis, and the origin [2.5]

79. $|x + y| = 4$
Symmetric to the origin [2.5]

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

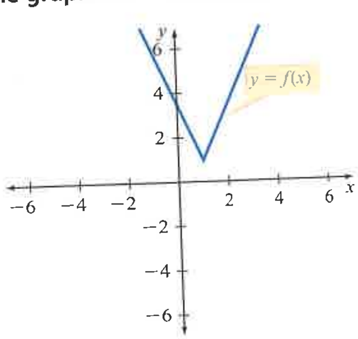
82. $g(x) = |x - 2| + |x + 2|$

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. $g(x) = f(x) - 2$
[2.5]

87. $g(x) = f(x + 3)$
[2.5]

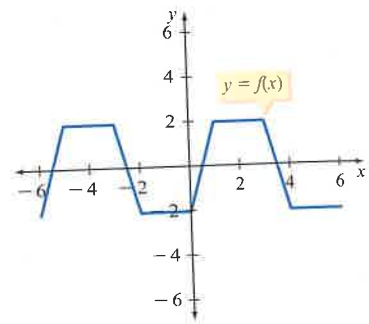
88. $g(x) = f(x - 1) - 3$
[2.5]

89. $g(x) = f(x + 2) - 1$
[2.5]

90. $g(x) = f(-x)$
[2.5]

91. $g(x) = -f(x)$
[2.5]

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



92. $g(x) = 2f(x)$
[2.5]

93. $g(x) = \dfrac{1}{2}f(x)$
[2.5]

94. $g(x) = f(2x)$ [2.5]

95. $g(x) = f\left(\dfrac{1}{2}x\right)$ [2.5]

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

a. $(f + g)(2)$ 11

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

c. $(f - g)(x)$
$x^2 - 2x - 3$

d. $(f \cdot g)(x)$
$3x^3 + 4x^2 - 5x - 2$ [2.6]

97. If $f(x) = 4x^2 - 3x - 1$, find the difference quotient
$$\frac{f(x + h) - f(x)}{h}$$
$8x + 4h - 3$ [2.6]

98. If $g(x) = x^3 - x$, find the difference quotient
$$\frac{g(x + h) - g(x)}{h}$$
$3x^2 + 3xh + h^2 - 1$ [2.6]

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]
18 ft/s

b. [2, 3]
15 ft/s

c. [2, 2.5]
13.5 ft/s

d. [2, 2.01]
12.03 ft/s

e. What appears to be the average velocity of the ball for the time interval $[2, 2 + \Delta t]$ as Δt approaches 0?
12 ft/s [2.6]

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

a. $(f \circ g)(3)$
5

b. $(g \circ f)(-3)$
-11

c. $(f \circ g)(x)$
$x^2 - 12x + 32$

d. $(g \circ f)(x)$
$x^2 + 4x - 8$ [2.6]

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

a. $(f \circ g)(-5)$ 79

b. $(g \circ f)(-5)$ 56

c. $(f \circ g)(x)$
$2x^2 - 4x + 9$

d. $(g \circ f)(x)$
$2x^2 + 6$ [2.6]

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.
$y = 1.171428571x + 5.19047619$

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.
19 m/s [2.7]

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.
$h = 0.0047952048t^2 - 1.756843157t + 180.4065934$

b. On the basis of this model, will the can ever empty?
No

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.
The regression equation is a model of the data and is not based on physical principles. [2.7]

Answers to 2, 3, and 14–18 are on page AA11.

CHAPTER 2 TEST

1. Find the midpoint and the length of the line segment with endpoints $(-2, 3)$ and $(4, -1)$.
Midpoint $(1,1)$, length $2\sqrt{13}$ [2.1]

2. Determine the x- and y-intercepts of the equation $x = 2y^2 - 4$. Then graph the equation.
$(-4, 0)$; $(0, \sqrt{2})$, $(0, -\sqrt{2})$ [2.1]

3. Graph the equation $y = |x + 2| + 1$. [2.1]

4. Find the center and radius of the circle that has the general form $x^2 - 4x + y^2 + 2y - 4 = 0$.
Center $(2, -1)$, radius 3 [2.1]

5. Determine the domain of the function

$$f(x) = -\sqrt{x^2 - 16}$$

Domain $\{x | x \geq 4 \text{ or } x \leq -4\}$ [2.2]

6. Find the elements a in the domain of $f(x) = x^2 + 6x - 17$ for which $f(a) = -1$. -8 and 2 [2.2]

7. Find the slope of the line that passes through the points with coordinates $(5, -2)$ and $(-1, 3)$. $-\frac{5}{6}$ [2.3]

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. $y = -2x + 7$ [2.3]

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 $3x - 2y = 4$. $y = -\frac{2}{3}x + \frac{2}{3}$ [2.3]

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?
$f(x) = (x + 3)^2 - 11$, $(-3, -11)$, $x = -3$ [2.4]

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, minimum [2.4]

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

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

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

c. $f(x) = x - 1$
Neither [2.5]

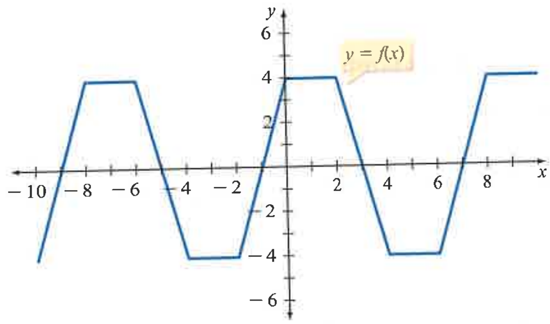
13. Classify the graph of each equation as being symmetric with respect to the x-axis, the y-axis, or the origin.

a. $y^2 = x + 1$
x-axis

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

c. $y = 3x^2 - 2$
y-axis [2.5]

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



14. $g(x) = 2f(x)$ [2.5]

15. $g(x) = f\left(\frac{1}{2}x\right)$ [2.5]

16. $g(x) = -f(x)$ [2.5]

17. $g(x) = f(x - 1) + 3$ [2.5]

18. $g(x) = f(-x)$ [2.5]

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

a. $(f - g)(x)$ $x^2 - 3x + 3$ **b.** $(f \cdot g)(-2)$ -40

c. $(f \circ g)(3)$ 22 **d.** $(g \circ f)(x)$ $2x^2 - 2x + 3$ [2.6]

20. Find the difference quotient of the function $f(x) = x^2 + 1$. $2x + h$ [2.6]

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? $x = 20$ ft, $y = 40$ ft [2.3]

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] 25 ft/s

b. [2, 2.5] 22.5 ft/s

c. [2, 2.01] 20.05 ft/s [2.6]

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.

$y = -7.98245614x + 767.122807$

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. 57 calories [2.7]

CUMULATIVE REVIEW EXERCISES

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

2. Which of the numbers -3, $-\frac{2}{3}$, $\frac{6}{\pi}$, 0, $\sqrt{16}$, and $\sqrt{2}$ are not rational numbers? $\frac{6}{\pi}$, $\sqrt{2}$ [P.1]

In Exercises 3 to 8, simplify the expression.

3. $3 + 4(2x - 9)$ $8x - 33$ [P.1]

4. $(-4xy^2)^3(-2x^2y^4)$ $128x^5y^{10}$ [P.2]

5. $\frac{24a^4b^3}{18a^4b^5}$ $\frac{4}{3b^2}$ [P.2]

6. $(2x + 3)(3x - 7)$ $6x^2 - 5x - 21$ [P.3]

7. $\frac{x^2 + 6x - 27}{x^2 - 9}$ $\frac{x + 9}{x + 3}$ [P.5]

8. $\frac{4}{2x - 1} - \frac{2}{x - 1}$ $\frac{-2}{(2x - 1)(x - 1)}$ [P.5]

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

9. $6 - 2(2x - 4) = 14$ 0 [1.1]

10. $x^2 - x - 1 = 0$ $\frac{1 \pm \sqrt{5}}{2}$ [1.3]

11. $(2x - 1)(x + 3) = 4$ $-\frac{7}{2}$, 1 [1.3]

12. $3x + 2y = 15$ $x = -\frac{2}{3}y + 5$ [1.1]

13. $x^4 - x^2 - 2 = 0$ $\pm\sqrt{2}$, $\pm i$ [1.4]

14. $3x - 1 < 5x + 7$ $x > -4$ [1.5]

15. Find the distance between the points $P_1(-2, -4)$ and $P_2(2, -3)$. $\sqrt{17}$ [2.1]

16. Given $G(x) = 2x^3 - 4x - 7$, find $G(-2)$. -15 [2.2]

17. Find the equation of the line that passes through the points $P_1(2, -3)$ and $P_2(-2, -1)$. $y = -\frac{1}{2}x - 2$ [2.3]

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? 100 oz [1.1]

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? Yes [2.4]

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? 0.04°F/min [2.3]