Section 3.3

In Exercises 24–29, find the vertex, y-intercept, and x-intercepts (if any) of the quadratic function. Sketch the graph, with these points labeled.

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

25. $g(x) = (x - 4)^2 + 1$

26. $h(x) = 2x^2 - 4x - 3$

27. $f(x) = -x^2 - 2x - 7$

28. $g(x) = -2(x - 1)(x + 2)$

29. $h(x) = (x + 2.4)(x - 1.7)$

30. Write the function $f(x) = (x - 1)^2 - 1$ in polynomial and x-intercept form.

31. Write the function $f(x) = x^2 - 3x - 4$ in transformation and x-intercept form.

32. Write the function $f(x) = -2(x - 3)(x + 1)$ in transformation and polynomial from.

Section 3.4

In Exercises 33–38, graph each function with its parent function on the same graph.

33. $f(x) = -\sqrt{x}$

34. $h(x) = \dfrac{1}{x + 2}$

35. $g(x) = 1.5|x|$

36. $h(x) = [-x]$

37. $f(x) = x^2 - 3$

38. $g(x) = \sqrt[3]{2x}$

In Exercises 39–42, list the transformations, in the order they should be performed on the graph of $g(x) = x^2$, to produce a graph of the function f.

39. $f(x) = 0.25x^2 + 2$

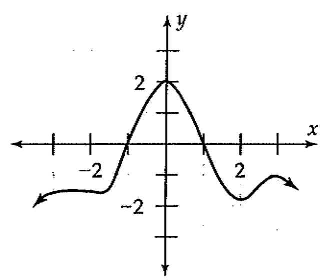
40. $f(x) = -(x + 4)^2 - 5$

41. $f(x) = -3(x - 7)^2 + 2$

42. $f(x) = (x - 2)^2$

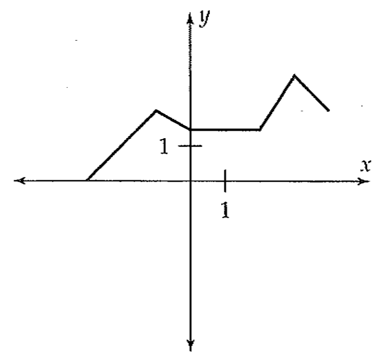
43. The figure shows the graph of a function f. If g is the function $g(x) = f(x + 2)$, then which of these statements is true?

a. The graph of g touches, but does not cross, the x-axis.
b. The graph of g touches, but does not cross, the y-axis.
c. The graph of g crosses the y-axis at $y = 4$.
d. The graph of g crosses the y-axis at the origin.
e. The graph of g crosses the x-axis at $x = -3$.



44. The graph of a function f is shown in the figure. On the same coordinate plane, carefully draw the graphs of the functions g and h whose rules are:

$$g(x) = -f(x) \qquad \text{and} \qquad h(x) = 1 - f(x)$$



45. U.S. Express Mail rates in 2002 are shown in the following table. Sketch the graph of the function e, whose rule is $e(x)$ = cost of sending a package weighing x pounds by Express Mail.

Express Mail

Letter Rate—Post Office to Addressee Service

Up to 8 ounces	$13.65
Over 8 ounces to 2 pounds	17.85
Up to 3 pounds	21.05
Up to 4 pounds	24.20
Up to 5 pounds	27.30
Up to 6 pounds	30.40
Up to 7 pounds	33.45

Section **3.4.A**

In Exercises 46–48, determine algebraically whether the graph of the given equation is symmetric with respect to the x-axis, the y-axis, or the origin.

46. $5y = 7x^2 - 2x$ **47.** $x^2 = y^2 + 2$ **48.** $x^2 + y^2 + 6y = -5$

In Exercises 49–51, determine whether the given function is even, odd, or neither.

49. $g(x) = 9 - x^2$ **50.** $f(x) = |x|x + 1$ **51.** $h(x) = 3x^5 - x(x^4 - x^2)$

52. Plot the points $(-2, 1)$, $(-1, 3)$, $(0, 1)$, $(3, 2)$, and $(4, 1)$ on coordinate axes.
- **a.** Suppose the points lie on the graph of an even function f. Plot the points $(2, f(2))$, $(1, f(1))$, $(0, f(0))$, $(-3, f(-3))$, and $(-4, f(-4))$.
- **b.** Suppose the points lie on the graph of an odd function g. Plot the points $(2, g(2))$, $(1, g(1))$, $(0, g(0))$, $(-3, g(-3))$, and $(-4, g(-4))$.

Section 3.5

53. If $f(x) = 3x + 2$ and $g(x) = x^3 + 1$, find each value.
a. $(f + g)(-1)$ **b.** $(f - g)(2)$ **c.** $(fg)(0)$

54. If $f(x) = \frac{1}{x - 1}$ and $g(x) = \sqrt{x^2 + 5}$, find the rule of each function and state its domain.

a. $(f + g)(x)$ **b.** $(f - g)(x)$ **c.** $(fg)(x)$ **d.** $\left(\frac{f}{g}\right)(x)$

55. If $g(x) = x^2 - 1$ then $g(x - 1) - g(x + 1) =$ __?__

Exercises 56–61 refer to the functions $f(x) = \frac{1}{x + 1}$ and $g(x) = x^3 + 3$.

56. $(f \circ g)(1) =$ __?__ **57.** $(g \circ f)(2) =$ __?__

58. $g(f(-2)) =$ __?__ **59.** $(g \circ f)(x - 1) =$ __?__

60. $g(2 + f(0)) =$ __?__ **61.** $f(g(1) - 1) =$ __?__

62. If $f(x) = \frac{1}{1 - x}$ and $g(x) = \sqrt{x}$, find the domain of the composite function $f \circ g$.

63. Find two functions f and g such that neither is the identity function and $(f \circ g)(x) = (2x + 1)^2$

64. The radius of an oil spill (in meters) is 50 times the square root of the time t (in hours).
a. Write the rule of a function f that gives the radius of the spill at time t.
b. Write the rule of a function g that gives the area of the spill at time t.
c. What are the radius and area of the spill after 9 hours?
d. When will the spill have an area of 100,000 square meters?

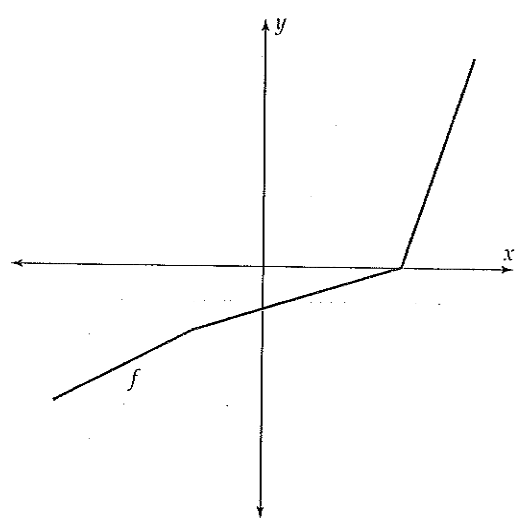
Section 3.5.A

65. Find the first eight terms of the orbit of $x = 2$ under the function $f(x) = (1 - x)^2$.

66. Describe the set of fixed points of the function $f(x) = [x]$.

Section 3.6

67. The graph of a function f is shown in the figure. Sketch the graph of the inverse of f.



In Exercises 68–73, find the inverse relation of each function. If the inverse is a function, write its rule in function notation.

68. $f(x) = x^3$

69. $f(x) = 1 - x^2$

70. $f(x) = |x|$

71. $f(x) = 2x + 1$

72. $f(x) = \sqrt{5 - x} + 7$

73. $f(x) = \sqrt[5]{x^3 + 1}$

In Exercises 74–76, determine whether or not the given function is one-to-one. Give reasons for your answer. If so, graph the inverse function.

74. $f(x) = 0.02x^3 - 0.04x^2 + 0.6x - 4$

75. $f(x) = \frac{1}{x}$

76. $f(x) = 0.2x^3 - 4x^2 + 6x - 15$

In Exercises 77–80, use composition to verify that f and g are inverses.

77. $f(x) = 4x - 6$ $\quad g(x) = 0.25x + 1.5$

78. $f(x) = x^3 - 1$ $\quad g(x) = \sqrt[3]{x + 1}$

79. $f(x) = \frac{2x + 1}{x - 3}$ $\quad g(x) = \frac{3x + 1}{x - 2}$

80. $f(x) = \frac{x + 1}{x - 1}$ $\quad g(x) = \frac{x + 1}{x - 1}$

Section 3.7

81. Find the average rate of change of the function $g(x) = \frac{x^3 - x + 1}{x + 2}$ as x changes from

a. -1 to 1 **b.** 0 to 2

82. Find the average rate of change of the function $f(x) = \sqrt{x^2 - x + 1}$ as x changes from

a. -3 to 0 **b.** -3 to 3.5 **c.** -3 to 5

83. If $f(x) = 2x + 1$ and $g(x) = 3x - 2$, find the average rate of change of the composite function $f \circ g$ as x changes from 3 to 5.

84. If $f(x) = x^2 + 1$ and $g(x) = x - 2$, find the average rate of change of the composite function $f \circ g$ as x changes from -1 to 1.

In Exercises 85–88, find the difference quotient of the function and simplify.

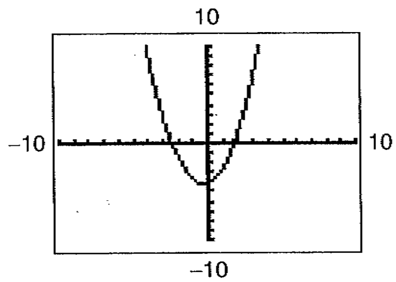
85. $f(x) = 3x + 4$

86. $g(x) = 4x - 1$

87. $g(x) = x^2 - 1$

88. $f(x) = x^2 + x$

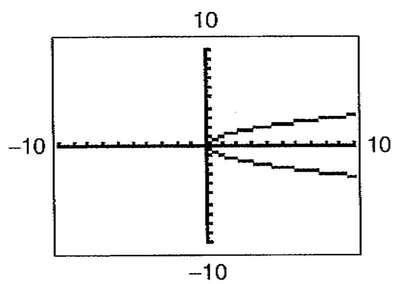
29.



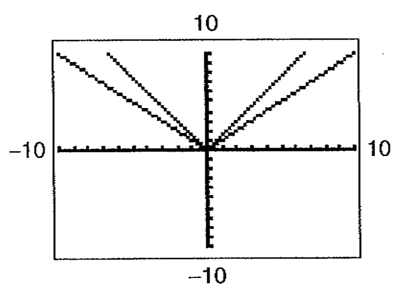
Vertex is $(-0.35, -4.2025)$.
The y-intercept is -4.08.
The x-intercepts are -2.4 and 1.7.

31. $f(x) = \left(x - \frac{3}{2}\right)^2 - \frac{25}{4}$ (transformation form)
$f(x) = (x - 4)(x + 1)$ (x-intercept form)

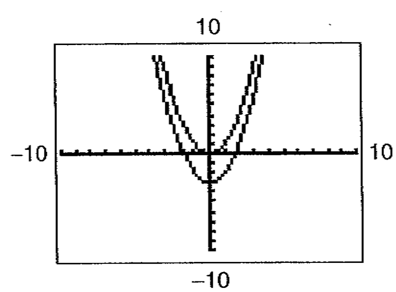
33. parent function: $f(x) = \sqrt{x}$



35. parent function: $g(x) = |x|$



37. parent function: $f(x) = x^2$

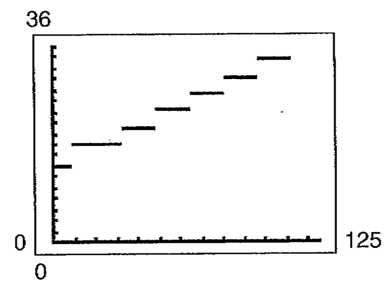


39. Compress the graph of g toward the x-axis by a factor of 0.25, then shift the graph vertically 2 units upward.

41. Shift the graph of g horizontally 7 units to the right; then stretch it away from the x-axis by a factor of 3; then reflect it across the x-axis; finally, shift the graph vertically 2 units upward.

43. e

45.



Note: the right endpoint of each segment is a part of the graph; the left endpoint is *not* a part of the graph.

47. x-axis, y-axis, origin

49. Even **51.** Odd

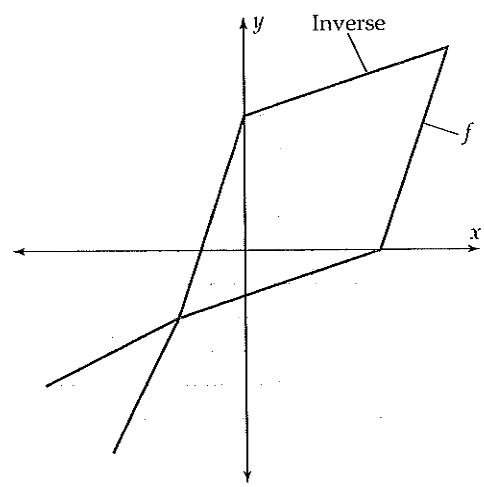
53. a. -1 **b.** -1 **c.** 2

55. $-4x$ **57.** $\frac{82}{27}$ **59.** $\frac{1}{x^3} + 3$ **61.** $\frac{1}{4}$

63. $f(x) = x^2, g(x) = 2x + 1$

65. 2, 1, 0, 1, 0, 1, 0, 1

67.

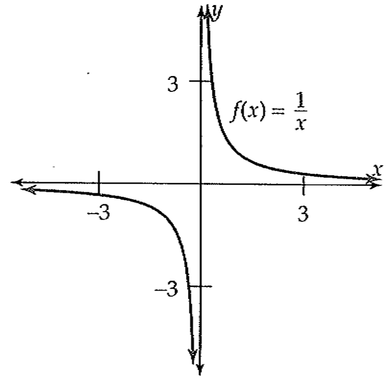


69. $x = 1 - y^2, y = \pm\sqrt{1 - x}$

71. $x = 2y + 1, f^{-1}(x) = \frac{x - 1}{2}$

73. $x = \sqrt[5]{y^3 + 1}, f^{-1}(x) = \sqrt[3]{x^5 - 1}$

75. The graph of f passes the horizontal line test and hence has an inverse function. It is easy to verify either geometrically [by reflecting the graph of f across the line $y = x$] or algebraically [by calculating $f(f(x))$] that f is its own inverse function.



77. $(g \circ f)(x) = 0.25(4x - 6) + 1.5 = x - 1.5 + 1.5 = x$
$(f \circ g)(x) = 4(0.25x + 1.5) - 6 = x + 6 - 6 = x$

79. $$(g \circ f)(x) = \frac{3\left(\frac{2x+1}{x-3}\right) + 1}{\left(\frac{2x+1}{x-3}\right) - 2} = \frac{\frac{3(2x+1) + 1(x-3)}{x-3}}{\frac{2x+1-2(x-3)}{x-3}} = \frac{\frac{7x}{x-3}}{\frac{7}{x-3}} = \frac{7x}{x-3} \cdot \frac{x-3}{7} = x$$

$$(f \circ g)(x) = \frac{2\left(\frac{3x+1}{x-2}\right) + 1}{\left(\frac{3x+1}{x-2}\right) - 3} = \frac{\frac{2(3x+1) + 1(x-2)}{x-2}}{\frac{3x+1-3(x-2)}{x-2}} = \frac{\frac{7x}{x-2}}{\frac{7}{x-2}} = \frac{7x}{x-2} \cdot \frac{x-2}{7} = x$$

81. a. $-\frac{1}{3}$ **b.** $\frac{5}{8}$

83. 6 **85.** 3 **87.** $2x + h$

89. a. For example, from −3 to 1
b. For example, from 1 to 2
c. For example, from 6 to 8
d. Both intervals are portions of the same line, so their slopes are the same.

91. a. \$290/ton **b.** \$230/ton **c.** \$212/ton

Chapter 3 **can do calculus**, page 237

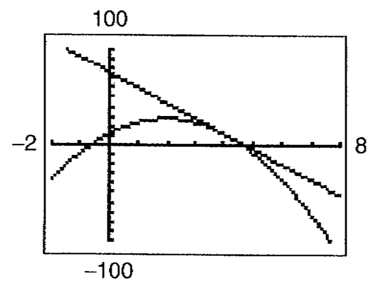
1. $s(t) = -16t^2 + 20t + 75$
−44 feet per second

2. 0.625 seconds The instantaneous velocity of the ball is 0 when the ball reaches its maximum height. Thus, the maximum height of the ball will be 81.25 feet.

3. $s(t) = -16t^2 + 300$; −96 feet per second

4. 14 **5.** −0.111111 **6.** 3 **7.** $2a$

8. instantaneous rate of change = −16; equation of tangent line at $t = 4$: $y = -16t + 76$



9. instantaneous rate of change = 25.132741
When $r = 1$, for each change of 1 unit in the radius, the surface area of the sphere will increase by approximately 25.132741 square units.

10. instantaneous rate of change = 100 dollars per phone When $x = 1000$, for every additional phone sold, the profit increases by approximately \$100.

Chapter 4

Section 4.1, page 248

1. Polynomial of degree 3; leading coefficient 1; constant term 1

3. Polynomial of degree 3; leading coefficient 1; constant term −1

5. Polynomial of degree 2; leading coefficient 1; constant term −3

7. Not a polynomial

9.

2	3	−8	0	9	5
		6	−4	−8	2
	3	−2	−4	1	7

quotient $3x^3 - 2x^2 - 4x + 1$;
remainder 7

11.

−3	2	5	0	−2	−8
		−6	3	−9	33
	2	−1	3	−11	25

quotient $2x^3 - x^2 + 3x - 11$;
remainder 25

13.

7	5	0	−3	−4	6
		35	245	1,694	11,830
	5	35	242	1,690	11,836

quotient $5x^3 + 35x^2 + 242x + 1690$;
remainder 11,836