

29. Let $f(x) = x^2 - 3x + 1$. Compute the following.
- | | | |
|--------------|----------------|-----------------------|
| (a) $f(1)$ | (e) $f(z)$ | (i) $ f(1) $ |
| (b) $f(0)$ | (f) $f(x + 1)$ | (j) $f(\sqrt{3})$ |
| (c) $f(-1)$ | (g) $f(a + 1)$ | (k) $f(1 + \sqrt{2})$ |
| (d) $f(3/2)$ | (h) $f(-x)$ | (l) $ 1 - f(2) $ |

30. Let $H(x) = 1 - x + x^2 - x^3$.
- (a) Which number is larger, $H(0)$ or $H(1)$?
- (b) Find $H(\frac{1}{2})$. Does $H(\frac{1}{2}) + H(\frac{1}{2}) = H(1)$?

31. Let $f(x) = 3x^2$. Find the following.
- | | | |
|-------------|----------------|--------------|
| (a) $f(2x)$ | (c) $f(x^2)$ | (e) $f(x/2)$ |
| (b) $2f(x)$ | (d) $[f(x)]^2$ | (f) $f(x)/2$ |

For checking: No two answers are the same.

32. Let $f(x) = 4 - 3x$. Find the following.
- | | | |
|--------------------|---------------|--------------|
| (a) $f(2)$ | (f) $2f(x)$ | (k) $1/f(x)$ |
| (b) $f(-3)$ | (g) $f(x^2)$ | (l) $f(-x)$ |
| (c) $f(2) + f(-3)$ | (h) $f(1/x)$ | (m) $-f(x)$ |
| (d) $f(2 + 3)$ | (i) $f[f(x)]$ | (n) $-f(-x)$ |
| (e) $f(2x)$ | (j) $x^2f(x)$ | |

33. Let $H(x) = 1 - 2x^2$. Find the following.
- | | |
|-------------------|----------------|
| (a) $H(\sqrt{2})$ | (c) $H(x + 1)$ |
| (b) $H(5/6)$ | (d) $H(x + h)$ |
34. (a) If $f(x) = 2x + 1$, does $f(3 + 1) = f(3) + f(1)$?
- (b) If $f(x) = 2x$, does $f(3 + 1) = f(3) + f(1)$?
- (c) If $f(x) = \sqrt{x}$, does $f(3 + 1) = f(3) + f(1)$?

35. Let $g(x) = 2$, for all x . Find each output.
- | | | |
|------------|------------|----------------|
| (a) $g(0)$ | (b) $g(5)$ | (c) $g(x + h)$ |
|------------|------------|----------------|
36. Let $g(t) = |t - 4|$. Find $g(3)$. Find $g(x + 4)$.
37. Let $f(x) = x^2 - 6x$. In each case, find all real numbers x (if any) that satisfy the given equation.
- | | | |
|-----------------|------------------|-----------------|
| (a) $f(x) = 16$ | (b) $f(x) = -10$ | (c) $f(x) = -9$ |
|-----------------|------------------|-----------------|
38. Let $g(t) = (4t - 6)/(t - 4)$. In each case, find all the real number solutions (if any) for the given equation.
- | | | |
|-----------------|----------------|----------------|
| (a) $g(t) = 14$ | (b) $g(t) = 4$ | (c) $g(t) = 0$ |
|-----------------|----------------|----------------|

For Exercises 39 and 40, refer to the demand function given in Example 7. In each case, solve the indicated equation for n . Round each answer to the nearest integer and interpret the result.

39. $p(n) = 8$ 40. $p(n) = 18$

In Exercises 41 and 42, p refers to the demand function given in Example 7. Now assume that a second economist proposes an alternative model f for the demand function:

$$f(n) = 4 + \frac{3000}{n + 100} \quad (100 \leq n \leq 1500)$$

where n is the number of tee shirts that can be sold per month at a price of $f(n)$ dollars per shirt.

41. At a price level of \$19 per shirt, compare the predictions for monthly sales obtained using each model. *Hint:* You need to solve each of the equations $p(n) = 19$ and $f(n) = 19$ and interpret the results.
42. Show that at a price level of \$10 per shirt, the model p predicts more than twice as many sales per month as does the model f . *Hint:* Solve each of the equations $p(n) = 10$ and $f(n) = 10$, and interpret the results.

In Exercises 43 and 44, let $T(x) = 2x^2 - 3x$. Find (and simplify) each expression.

- | | | |
|--------------------|----------------|---------------------------|
| 43. (a) $T(x + 2)$ | (b) $T(x - 2)$ | (c) $T(x + 2) - T(x - 2)$ |
| 44. (a) $T(x + h)$ | (b) $T(x - h)$ | (c) $T(x + h) - T(x - h)$ |

In Exercises 45–48, refer to the following table. The left-hand column of the table lists four errors to avoid in working with function notation. In each case, use the function $f(x) = x^2 - 1$ and give a numerical example showing that the expressions on each side of the equation are not equal.

| Errors to avoid | Numerical example showing that the equation is not, in general, valid |
|--|---|
| 45. $f(a + b) = f(a) + f(b)$ | |
| 46. $f(ab) = f(a) \cdot f(b)$ | |
| 47. $f\left(\frac{1}{a}\right) = \frac{1}{f(a)}$ | |
| 48. $\frac{f(a)}{f(b)} = \frac{a}{b}$ | |

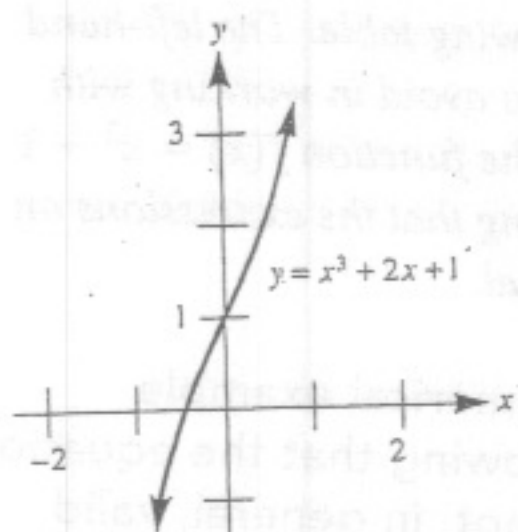
B

49. Let $f(x) = (x - a)/(x + a)$.
- (a) Find $f(a)$, $f(2a)$, and $f(3a)$. Is it true that $f(3a) = f(a) + f(2a)$?
- (b) Show that $f(5a) = 2f(2a)$.
50. Let $k(x) = 5x^3 + \frac{5}{x^3} - x - \frac{1}{x}$. Show that $k(x) = k(1/x)$.
51. Let $f(x) = 2x + 3$. Find values for a and b such that the equation $f(ax + b) = x$ is true for all values of x . *Hint:* Use the fact that if two polynomials (in the variable x) are equal for all values of x , then the corresponding coefficients are equal.
52. Let $f(t) = (t - x)/(t + y)$. Show that

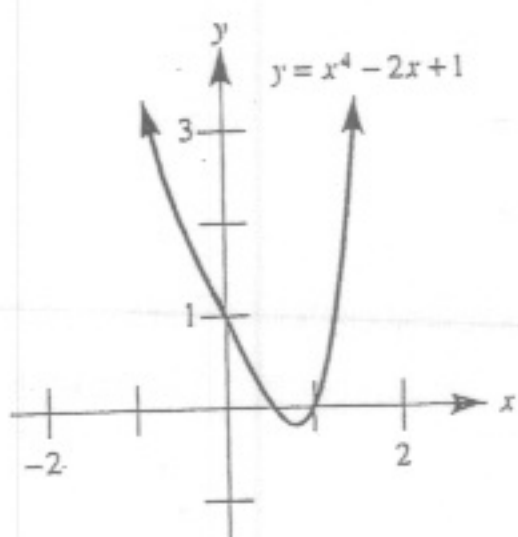
$$f(x + y) + f(x - y) = \frac{-2y^2}{x^2 + 2xy}$$

53. Let $f(z) = \frac{3z - 4}{5z - 3}$. Find $f\left(\frac{3z - 4}{5z - 3}\right)$.
54. Let $F(x) = \frac{ax + b}{cx - a}$. Show that $F\left(\frac{ax + b}{cx - a}\right) = x$, where $a^2 + bc \neq 0$.
55. If $f(x) = -2x^2 + 6x + k$ and $f(0) = -1$, find k .
56. If $g(x) = x^2 - 3xk - 4$ and $g(1) = -2$, find k .
57. Let $h(x) = x^2 - 4x - c$. Find a nonzero value for c such that $h(c) = c$.
58. Let the function L be defined by the following rule: $L(x)$ is the exponent to which 2 must be raised to yield x . (For the moment, we won't concern ourselves with the domain and range.) Then $L(8) = 3$, for example, since the exponent to

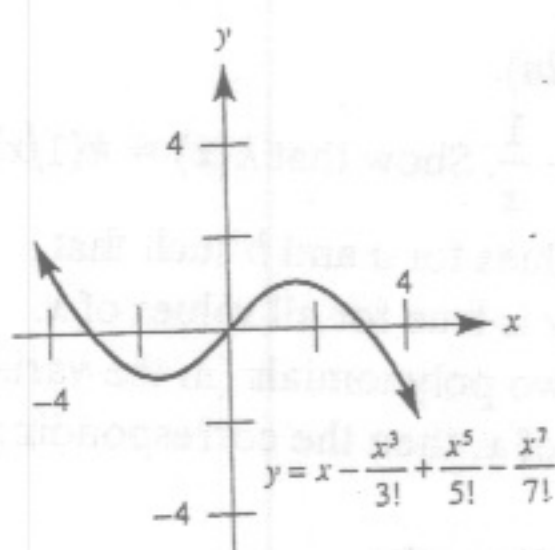
71. $[-0.453, \infty)$



73. $(-\infty, 0.544) \cup (1, \infty)$



75. $(-3.079, 0) \cup (3.079, \infty)$



77. (a) April through September
(b) January, October, November, December

79. $(-\infty, -2] \cup [2, \infty)$

81. $(-\infty, 0) \cup (\frac{1}{2}, \infty)$ 83. $(\frac{1}{5}, \frac{4}{5})$

85. $c = 2$

Chapter 2 Review Exercises

1. True 3. False 5. False

7. True 9. False 11. False

13. $x = \frac{1}{3}, -\frac{1}{2}$ 15. $x = -6, 4$

17. $x = -1, 10$ 19. $x = \frac{2}{3}, 3$

21. $t = \frac{-1 \pm \sqrt{3}}{2}$ 23. $x = -6, -8$

25. $x = 256, 6561$ 27. $x = \frac{1}{4}$

29. $x = 10$ 31. $x = 2$ 33. $x = \frac{1}{2y}$

35. $x = \frac{a+b}{ab}, -\frac{2}{a}$

37. $x = -a$ or $x = -b$

39. $(-2, 1)$ 41. $[-\frac{1}{2}, \frac{1}{2}]$

43. $(-\infty, -2] \cup [3, \infty)$ 45. $(-8$

47. $(3 - \sqrt{10}, 3 + \sqrt{10})$

49. $(-5, -3) \cup (3, 5)$ 51. $(-2, c$

53. $(-\frac{5}{2}, 4)$

55. $(-\infty, -\sqrt{\frac{3+\sqrt{5}}{2}}) \cup$

$(-\sqrt{\frac{3-\sqrt{5}}{2}}, 0) \cup$

$(0, \sqrt{\frac{3-\sqrt{5}}{2}}) \cup (\sqrt{\frac{3+\sqrt{5}}{2}}, \infty)$

57. $(-\infty, 3 - 2\sqrt{2}) \cup [3 + 2\sqrt{2}, \infty)$

59. $x^2 + 7x + 12 = 0$ 61. 7 and 12

63. $-1 + \sqrt{2}$ cm

65. $(16 \text{ cm}, \infty)$ 67. 21, 22, 23

69. $\frac{-(a+b) + \sqrt{a^2 + 6ab + b^2}}{4}$

71. The ball thrown from 100 ft.

73. $x = \sqrt{2}/2$ 75. $\frac{r}{1 + \sqrt{2}}$

Chapter 2 Test

1. (a) $x = -5, 1$ (b) $x = -2 \pm \sqrt{5}$

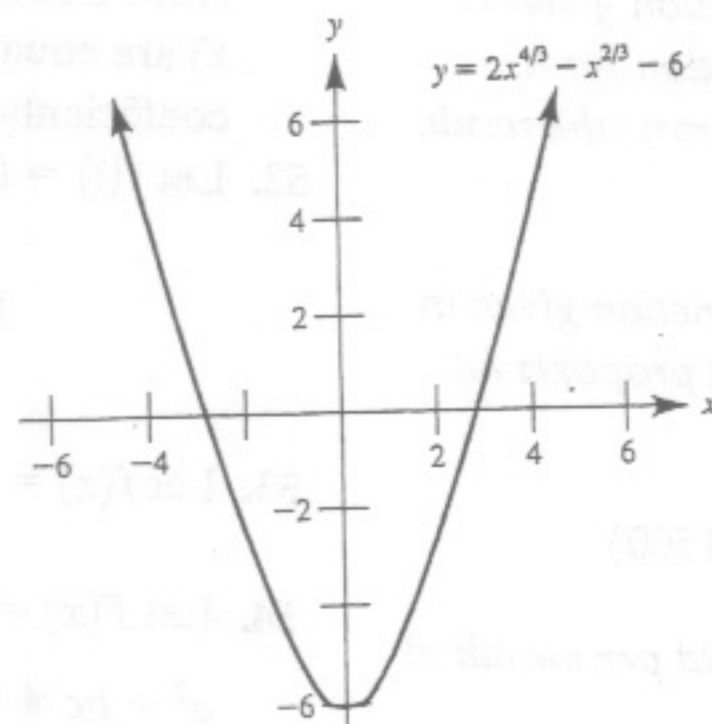
2. $x = \pm 2, \pm \sqrt{3}$ 3. $x = -2, 2$

4. $x = -\frac{1}{3}, 1$ 5. -4

6. $x^2 - 4x - 59 = 0$

7. $x = \pm \sqrt{\frac{3 + \sqrt{13}}{2}} \approx \pm 1.817$

8. (a) $x \approx -2.83, 2.83$



(b) $x = \pm 2\sqrt{2} \approx \pm 2.83$ 9. $(-\infty, 3]$

10. $(\frac{27}{10}, \frac{31}{10})$ 11. $[\frac{7}{3}, 3]$ 12. $[-8, \infty)$

13. $(-2, \frac{-3 - \sqrt{3}}{3}) \cup (-1, \frac{-3 + \sqrt{3}}{3}) \cup$

$(0, \infty)$ 14. $[-\frac{3}{2}, \frac{3}{2}]$ 15. $(-4, -7)$

16. $x = 6$ is a solution to the original equation. However, $x = -1$ results in the statement $\sqrt{4} = -2$, which is false. Thus $x = -1$ is an extraneous solution of the original equation, even though it

is a solution to the subsequent equation $x^2 - 5x - 6 = 0$.

CHAPTER 3

Exercise Set 3.1

1. (a) $g(1975) = \$2.00$

(b) $g(1995) - g(1975) = \$2.25$; The minimum wage increased \$2.25 from 1975 to 1995. 3. (a) range

(b) $h(\text{Mars}) = 2$ (c) $h(\text{Neptune})$;

Neptune has more moons than does Pluto. 5. (a) f and g (b) range of f :

$\{1, 2, 3\}$; range of g : $\{2, 3\}$ 7. (a) g

(b) range of g : $\{i, j\}$ 9. (a) $(-\infty, \infty)$

(b) $(-\infty, \frac{1}{3}) \cup (\frac{1}{3}, \infty)$ (c) $(-\infty, \frac{1}{3}]$

(d) $(-\infty, \infty)$ 11. (a) $(-\infty, \infty)$

(b) $(-\infty, -3) \cup (-3, 3) \cup (3, \infty)$

(c) $(-\infty, -3) \cup [3, \infty)$ (d) $(-\infty, \infty)$

13. (a) $(-\infty, \infty)$

(b) $(-\infty, 3) \cup (3, 5) \cup (5, \infty)$

(c) $(-\infty, 3] \cup [5, \infty)$ (d) $(-\infty, \infty)$

15. (a) $(-\infty, -3) \cup (-3, \infty)$

(b) $(-\infty, -3) \cup [2, \infty)$

(c) $(-\infty, -3) \cup (-3, \infty)$

17. domain: $(-\infty, \infty)$; range: $(-\infty, \infty)$

19. domain: $(-\infty, \infty)$; range: $(-\infty, \infty)$

21. domain: $(-\infty, 6) \cup (6, \infty)$;

range: $(-\infty, \frac{4}{3}) \cup (\frac{4}{3}, \infty)$

23. (a) domain: $(-\infty, 5) \cup (5, \infty)$;

range: $(-\infty, 1) \cup (1, \infty)$

(b) domain: $(-\infty, \sqrt[3]{5}) \cup (\sqrt[3]{5}, \infty)$;

range: $(-\infty, 1) \cup (1, \infty)$

25. domain: $(-\infty, \infty)$; range: $[4, \infty)$

27. (a) $y = (x - 3)^2$ (b) $y = x^2 - 3$

(c) $y = (3x)^2$ (d) $y = 3x^2$

29. (a) -1 (b) 1 (c) 5 (d) $-\frac{5}{4}$

(e) $z^2 - 3z + 1$ (f) $x^2 - x - 1$

(g) $a^2 - a - 1$ (h) $x^2 + 3x + 1$

(i) 1 (j) $4 - 3\sqrt{3}$ (k) $1 - \sqrt{2}$

(l) 2 31. (a) $12x^2$ (b) $6x^2$ (c) $3x^4$

(d) $9x^4$ (e) $\frac{3}{4}x^2$ (f) $\frac{3}{2}x^2$ 33. (a) -3

(b) $-\frac{7}{18}$ (c) $-2x^2 - 4x - 1$

(d) $1 - 2x^2 - 4xh - 2h^2$ 35. (a) 2

(b) 2 (c) 2 37. (a) $x = -2, 8$

(b) no real solutions (c) $x = 3$

39. 1041 tee shirts per month

41. first model: 124 sales; second

model: 100 sales 43. (a) $2x^2 + 5x + 2$

(b) $2x^2 - 11x + 14$ (c) $16x - 12$

45. $a = 1$ and $b = 2$ 47. $a = 2$

49. (a) $f(a) = 0, f(2a) = \frac{1}{3}, f(3a) = \frac{1}{2}$;

No 51. $a = \frac{1}{2}$ and $b = -\frac{3}{2}$ 53. z

55. $k = -1$ 57. $c = 6$ 59. 0

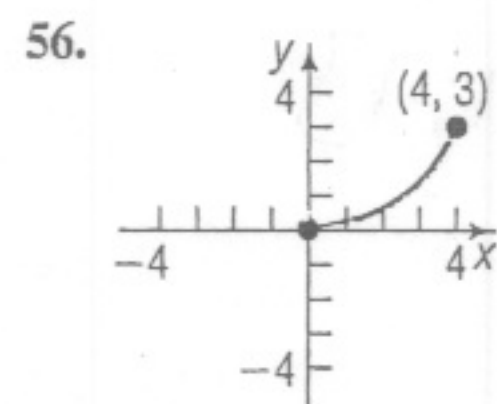
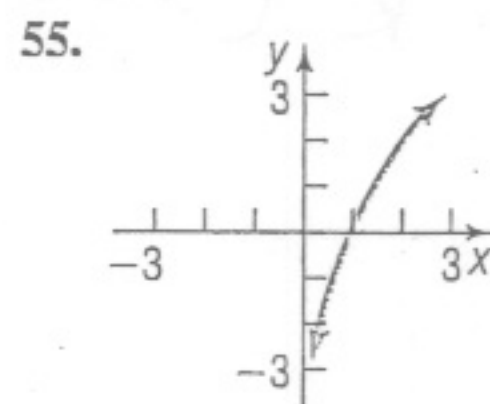
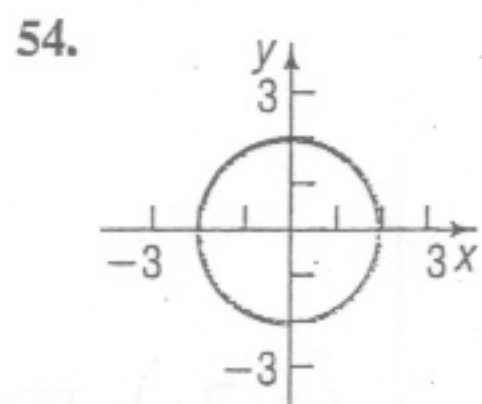
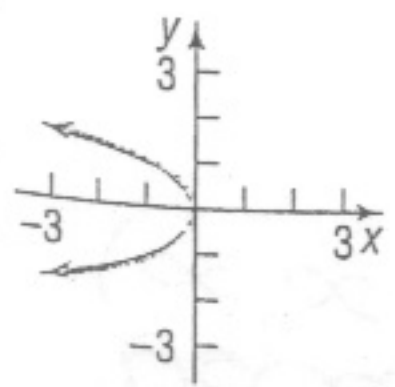
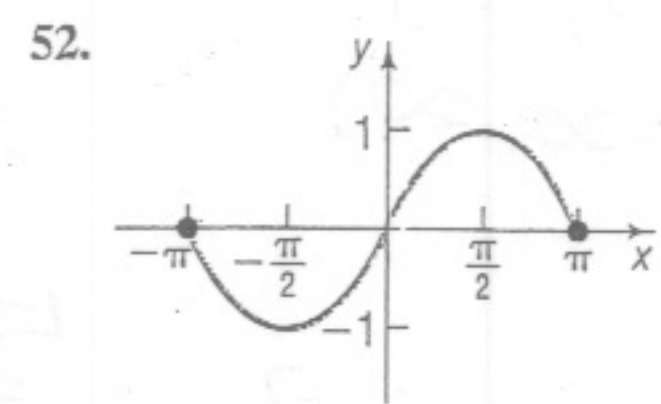
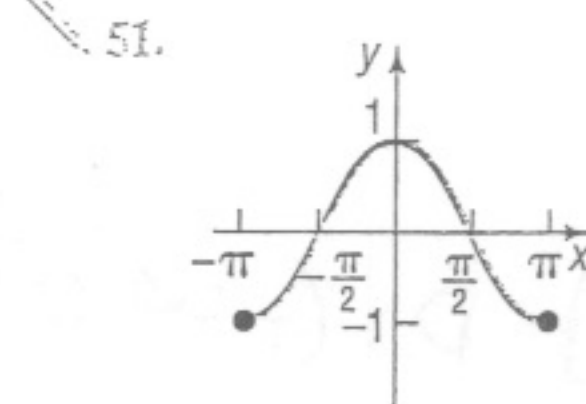
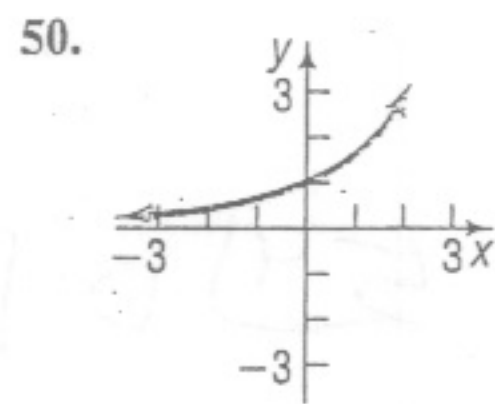
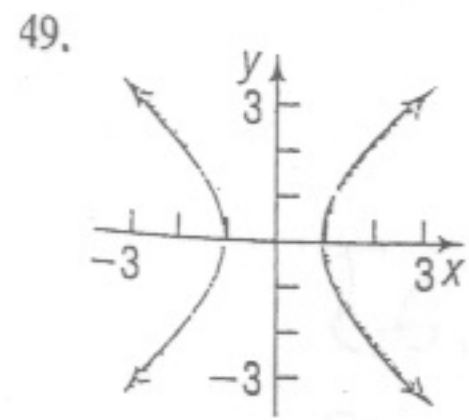
In Problems 13–20, find the following values for each function:

- (a) $f(0)$ (b) $f(1)$ (c) $f(-1)$ (d) $f(-x)$ (e) $-f(x)$ (f) $f(x+1)$ (g) $f(2x)$ (h) $f(x+h)$
13. $f(x) = 2x + 5$ 14. $f(x) = -3x + 1$ 15. $f(x) = 3x^2 + 2x - 4$ 16. $f(x) = -2x^2 + x - 1$
 17. $f(x) = \frac{x}{x^2 + 1}$ 18. $f(x) = \frac{x^2 - 1}{x + 4}$ 19. $f(x) = |x| + 4$ 20. $f(x) = \sqrt{x^2 + x}$

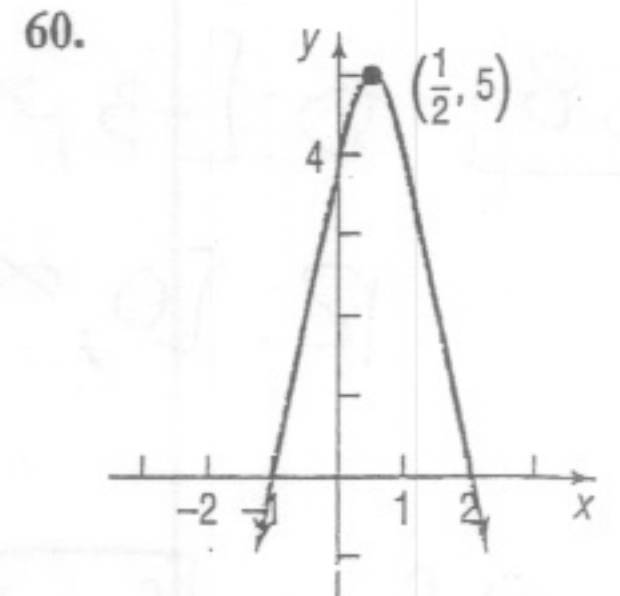
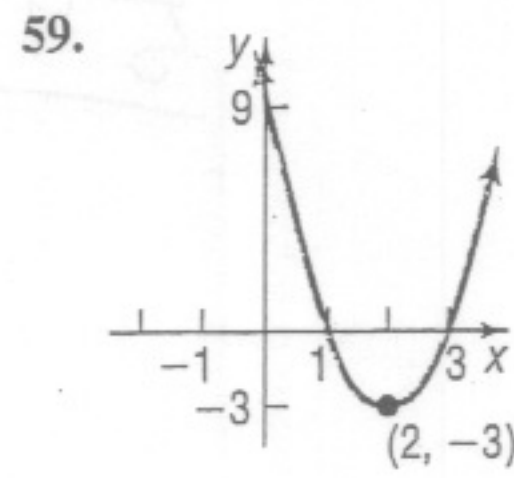
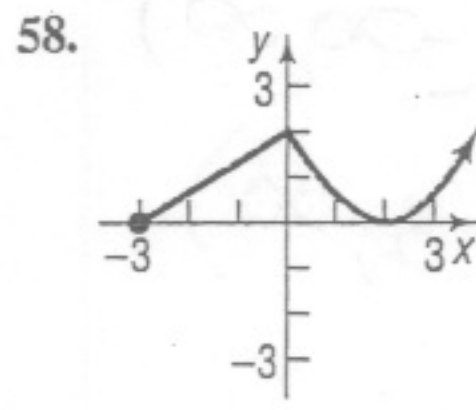
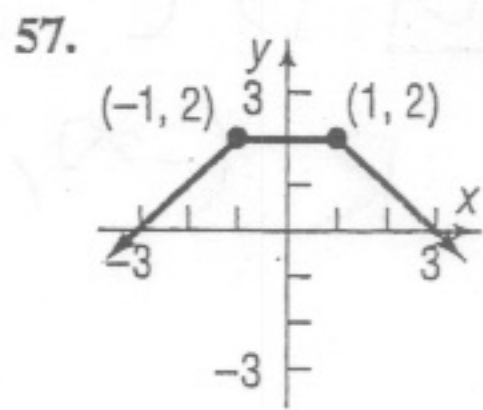
Stations Check
20. (f)

In Problems 49–60, determine whether the graph is that of a function by using the vertical-line test. If it is, use the graph to find:

- (a) Its domain and range (b) The intercepts, if any



98 CHAPTER 2 Functions and Their Graphs



In Problems 33–46, find the domain of each function.

33. $f(x) = -5x + 4$ 34. $f(x) = x^2 + 2$ 35. $f(x) = \frac{x}{x^2 + 1}$ 36. $f(x) = \frac{x^2}{x^2 + 1}$
 $g(x) = \frac{x}{x^2 - 16}$ 38. $h(x) = \frac{2x}{x^2 - 4}$ 39. $F(x) = \frac{x - 2}{x^3 + x}$ 40. $G(x) = \frac{x + 4}{x^3 - 4x}$

13. (a) 5 (b) 7 (c) 3 (d) $-2x + 5$ (e) $-2x - 5$ (f) $2x + 7$ (g) $4x + 5$ (h) $2x + 2h + 5$ 14. (a) 1 (b) -2 (c) 4
 (d) $3x + 1$ (e) $3x - 1$ (f) $-3x - 2$ (g) $-6x + 1$ (h) $-3x - 3h + 1$ 15. (a) -4 (b) 1 (c) -3 (d) $3x^2 - 2x - 4$
 (e) $-3x^2 - 2x + 4$ (f) $3x^2 + 8x + 1$ (g) $12x^2 + 4x - 4$ (h) $3x^2 + 6xh + 3h^2 + 2x + 2h - 4$ 16. (a) -1 (b) -2 (c) -4
 (d) $-2x^2 - x - 1$ (e) $2x^2 - x + 1$ (f) $-2x^2 - 3x - 2$ (g) $-8x^2 + 2x - 1$ (h) $-2x^2 - 4xh - 2h^2 + x + h - 1$

49) ~~D: $(-\infty, \infty)$~~
 $(-\infty, -1] \cup [1, \infty)$
 R: $(-\infty, \infty)$

50) D: $(-\infty, \infty)$
 R: $(0, \infty)$

51) D: $[-\pi, \pi]$
 R: $[-1, 1]$

52) D: $[-\pi, \pi]$
 R: $[-1, 1]$

53) D: $(-\infty, 0]$
 R: $(-\infty, \infty)$

54) D: $[-2, 2]$
 R: $[-2, 2]$

55) D: $(0, \infty)$
 R: $(-\infty, \infty)$

56) D: $[0, 4]$
 R: $[0, 3]$

57) D: ~~$(-\infty, \infty)$~~
 R: $(-\infty, 2]$

58) D: $[-3, \infty)$
 R: $[0, \infty)$

59) D: $(-\infty, \infty)$
 R: $[-3, \infty)$

60) D: $(-\infty, \infty)$
 R: $(-\infty, 5]$

20 f $\sqrt{(x+1)^2 + x + 1}$
 $\sqrt{x^2 + 2x + 1 + x + 1}$
 $\sqrt{x^2 + 3x + 2}$