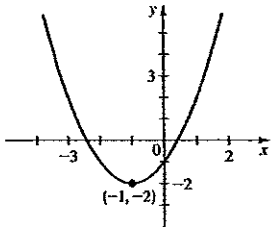
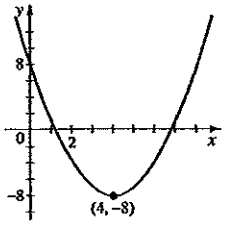
21. (a) $f(x) = (x + 1)^2 - 2$
(b)



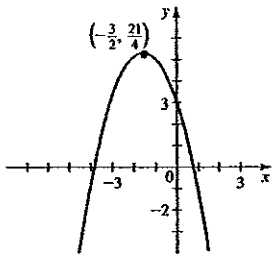
(c) Minimum $f(-1) = -2$

22. (a) $f(x) = (x - 4)^2 - 8$
(b)



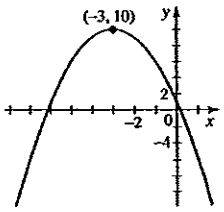
(c) Minimum $f(4) = -8$

23. (a) $f(x) = -\left(x + \frac{3}{2}\right)^2 + \frac{21}{4}$
(b)



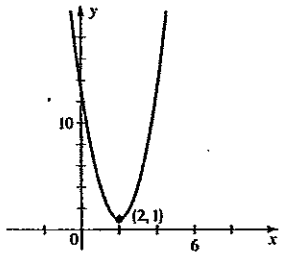
(c) Maximum $f\left(-\frac{3}{2}\right) = \frac{21}{4}$

24. (a) $f(x) = -(x + 3)^2 + 10$
(b)



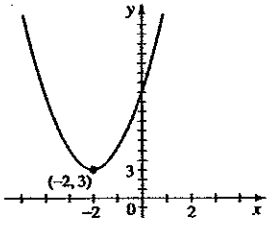
(c) Maximum $f(-3) = 10$

25. (a) $g(x) = 3(x - 2)^2 + 1$
(b)



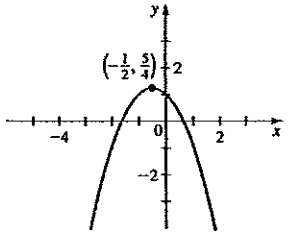
(c) Minimum $g(2) = 1$

26. (a) $g(x) = 2(x + 2)^2 + 3$
(b)



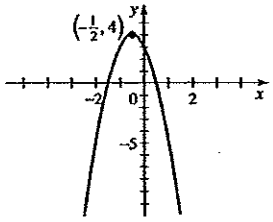
(c) Minimum $g(-2) = 3$

27. (a) $h(x) = -\left(x + \frac{1}{2}\right)^2 + \frac{5}{4}$
(b)



(c) Maximum $h\left(-\frac{1}{2}\right) = \frac{5}{4}$

28. (a) $h(x) = -4\left(x + \frac{1}{2}\right)^2 + 4$
(b)



(c) Maximum $h\left(-\frac{1}{2}\right) = 4$

29. Minimum $f\left(-\frac{1}{2}\right) = \frac{3}{4}$ **30.** Maximum $f\left(\frac{3}{2}\right) = \frac{13}{4}$
31. Maximum $f(-3.5) = 185.75$ **32.** Minimum $f(-2) = 73$
33. Minimum $f(0.6) = 15.64$ **34.** Minimum $g\left(\frac{15}{2}\right) = -5625$
35. Minimum $h(-2) = -8$ **36.** Maximum $f(-3) = 10$
37. Maximum $f(-1) = \frac{7}{2}$ **38.** Minimum $g(2) = -1$
39. $f(x) = 2x^2 - 4x$ **40.** $f(x) = -3(x - 3)^2 + 4$
41. $(-\infty, \infty)$, $(-\infty, 1]$ **42.** $(-\infty, \infty)$, $[-4, \infty)$
43. $(-\infty, \infty)$, $\left(-\frac{23}{2}, \infty\right)$ **44.** $(-\infty, \infty)$, $(-\infty, 7)$
45. (a) -4.01 (b) -4.011025
46. (a) 1.18 (b) $\dfrac{8 + \sqrt{2}}{8} \approx 1.176777$
47. Local maximum 2; local minimums -1, 0 **48.** Local maximums 1, 2; local minimum -1 **49.** Local maximums 0, 1; local minimums -2, -1 **50.** Local maximums 2, 3; local minimums 0, -1 **51.** Local maximum ≈ 0.38 when $x \approx -0.58$; local minimum ≈ -0.38 when $x \approx 0.58$
52. Local maximum ≈ 4.00 when $x \approx 1.00$; local minimum ≈ 2.81 when $x \approx -0.33$
53. Local maximum ≈ 0 when $x = 0$; local minimum ≈ -13.61 when $x \approx -1.71$; local minimum ≈ -73.32 when $x \approx 3.21$
54. Local maximum ≈ 13.02 when $x \approx 1.04$; local maximum ≈ -7.87 when $x \approx -1.93$; local minimum ≈ -13.02 when $x \approx -1.04$; local minimum ≈ 7.87 when $x \approx 1.93$
55. Local maximum ≈ 5.66 when $x \approx 4.00$
56. Local maximum ≈ 0.32 when $x \approx 0.75$ **57.** Local maximum ≈ 0.38 when $x \approx -1.73$; local minimum ≈ -0.38 when $x \approx 1.73$ **58.** Local maximum ≈ 1.33 when $x \approx -0.5$
59. 25 ft **60.** (a) 55 ft (b) 204.9 ft **61.** \$4000, 100 units
62. \$450, 1500 cans **63.** 30 times **64.** 150 min, 4.5 mg/L
65. 50 trees per acre **66.** 7.5 mi/h **67.** 20 mi/h **68.** 3.96°C
69. $r \approx 0.67$ cm

3.6

Section 3.6 page 210

1. $A(w) = 3w^2, w > 0$ **2.** $A(w) = w^2 + 10w$
3. $V(w) = \frac{1}{2}w^3, w > 0$ **4.** $V(r) = 4\pi r^3$
5. $A(x) = 10x - x^2, 0 < x < 10$ **6.** $P(x) = 2x + \dfrac{32}{x}, x > 0$
7. $A(x) = (\sqrt{3}/4)x^2, x > 0$ **8.** $S(V) = 6V^{2/3}, V > 0$
9. $r(A) = \sqrt{A/\pi}, A > 0$ **10.** $A(C) = C^2/(4\pi), C > 0$
11. $S(x) = 2x^2 + 240/x, x > 0$ **12.** $L(d) = \frac{5}{7}d$
13. $D(t) = 25t, t \geq 0$ **14.** $P(x) = 60x - x^2$
15. $A(b) = b\sqrt{4 - b}, 0 < b < 4$ **16.** $P(x) = (3 + \sqrt{5})x$

17. $A(h) = 2h\sqrt{100 - h^2}, 0 < h < 10$
18. $h(r) = 300/(\pi r^2)$ **19.** (b) $p(x) = x(19 - x)$
(c) 9.5, 9.5 **20.** 50, 50 **21.** $-12, -12$ **22.** 5 ft by 5 ft
23. (b) $A(x) = x(2400 - 2x)$ (c) 600 ft by 1200 ft
24. (a) $A(w) = -\frac{5}{2}(w^2 - 150w)$ (b) 14,062.5 ft^2
25. (a) $f(w) = 8w + 7200/w$ (b) Width along road is 30 ft, length is 40 ft (c) 15 ft to 60 ft
26. (a) $A(x) = \frac{1}{8}x^2 - \frac{5}{4}x + \frac{25}{4}$ (b) 5 cm
27. (a) $R(p) = -3000p^2 + 57{,}000p$ (b) \$19 (c) \$9.50
28. (a) $P(x) = 80 + 12x - 2x^2$ (b) \$13, \$98
29. (a) $A(x) = 15x - \left(\frac{\pi + 4}{8}\right)x^2$
(b) Width $\approx$ 8.40 ft, height of rectangular part $\approx$ 4.20 ft
30. (a) $V(x) = 4x^3 - 64x^2 + 240x, 0 < x < 6$
(b) $1.174 \le x \le 3.898$ (c) 262.682 in^3
31. (a) $A(x) = x^2 + 48/x$ (b) Height $\approx$ 1.44 ft, width $\approx$ 2.88 ft **32.** 3.27 by 5.33
33. (a) $A(x) = 2x + 200/x$ (b) 10 m by 10 m
34. (a) $T(x) = \frac{1}{2}\sqrt{x^2 - 14x + 53} + \frac{1}{5}x$ (b) 6.13 mi from point B **35.** (a) $E(x) = 14\sqrt{25 + x^2} + 10(12 - x)$
(b) To point C, 5.1 mi from point B **36.** (b) 9.23 by 13.00

Section 3.7 ■ page 219

1. $(f + g)(x) = x^2 + x - 3, (-\infty, \infty)$;
$(f - g)(x) = -x^2 + x - 3, (-\infty, \infty)$;
$(fg)(x) = x^3 - 3x^2, (-\infty, \infty)$;
$\left(\frac{f}{g}\right)(x) = \frac{x - 3}{x^2}, (-\infty, 0) \cup (0, \infty)$

2. $(f + g)(x) = 4x^2 + 2x - 1, (-\infty, \infty)$;
$(f - g)(x) = -2x^2 + 2x + 1, (-\infty, \infty)$;
$(fg)(x) = 3x^4 + 6x^3 - x^2 - 2x, (-\infty, \infty)$;
$\left(\frac{f}{g}\right)(x) = \frac{x^2 + 2x}{3x^2 - 1}, x \ne \pm\frac{1}{\sqrt{3}}$

3. $(f + g)(x) = \sqrt{4 - x^2} + \sqrt{1 + x}, [-1, 2]$;
$(f - g)(x) = \sqrt{4 - x^2} - \sqrt{1 + x}, [-1, 2]$;
$(fg)(x) = \sqrt{-x^3 - x^2 + 4x + 4}, [-1, 2]$;
$\left(\frac{f}{g}\right)(x) = \sqrt{\frac{4 - x^2}{1 + x}}, (-1, 2]$

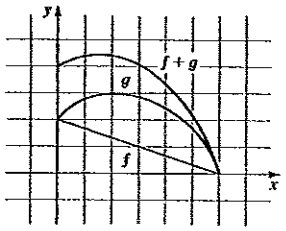
4. $(f + g)(x) = \sqrt{9 - x^2} + \sqrt{x^2 - 4}, [-3, -2] \cup [2, 3]$;
$(f - g)(x) = \sqrt{9 - x^2} - \sqrt{x^2 - 4}, [-3, -2] \cup [2, 3]$;
$(fg)(x) = \sqrt{-x^4 + 13x^2 - 36}, [-3, -2] \cup [2, 3]$;
$\left(\frac{f}{g}\right)(x) = \sqrt{\frac{9 - x^2}{x^2 - 4}}, [-3, -2) \cup (2, 3]$

5. $(f + g)(x) = \frac{6x + 8}{x^2 + 4x}, x \ne -4, x \ne 0$;
$(f - g)(x) = \frac{-2x + 8}{x^2 + 4x}, x \ne -4, x \ne 0$;
$(fg)(x) = \frac{8}{x^2 + 4x}, x \ne -4, x \ne 0$;
$\left(\frac{f}{g}\right)(x) = \frac{x + 4}{2x}, x \ne -4, x \ne 0$

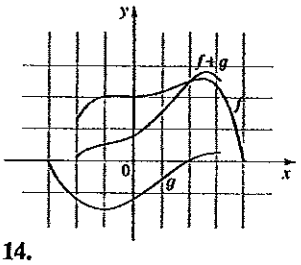
6. $(f + g)(x) = \frac{2 + x}{x + 1}, x \ne -1$;
$(f - g)(x) = \frac{2 - x}{x + 1}, x \ne -1$;
$(fg)(x) = \frac{2x}{(x + 1)^2}, x \ne -1$; $\left(\frac{f}{g}\right)(x) = \frac{2}{x}, x \ne -1, x \ne 0$

7. $[0,1]$ **8.** $[-1, 0) \cup (0, \infty)$ **9.** $(3, \infty)$
10. $[-3, 1) \cup (1, \infty)$

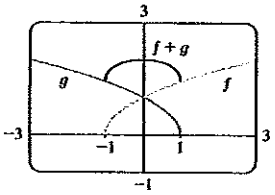
11.



12.



13.



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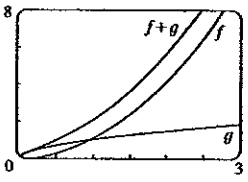
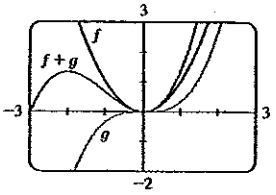
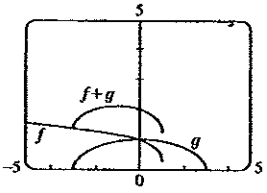


15.



16.



17. (a) 1 (b) -23 **18.** (a) 16 (b) -47 **19.** (a) -11 (b) -119 **20.** (a) -29 (b) -2 **21.** (a) $-3x^2 + 1$ (b) $-9x^2 + 30x - 23$ **22.** (a) $9x - 20$ (b) $-x^4 + 4x^2 - 2$
23. 4 **24.** 3 **25.** 5 **26.** 0 **27.** 4 **28.** -2
29. $(f \circ g)(x) = 8x + 1, (-\infty, \infty)$;
$(g \circ f)(x) = 8x + 11, (-\infty, \infty)$;
$(f \circ f)(x) = 4x + 9, (-\infty, \infty)$;
$(g \circ g)(x) = 16x - 5, (-\infty, \infty)$
30. $(f \circ g)(x) = 3x - 5, (-\infty, \infty)$;
$(g \circ f)(x) = 3x - \frac{5}{2}, (-\infty, \infty)$;
$(f \circ f)(x) = 36x - 35, (-\infty, \infty)$; $(g \circ g)(x) = \frac{x}{4}, (-\infty, \infty)$

31. $(f \circ g)(x) = (x+1)^2, (-\infty, \infty)$;
$(g \circ f)(x) = x^2 + 1, (-\infty, \infty)$; $(f \circ f)(x) = x^4, (-\infty, \infty)$;
$(g \circ g)(x) = x + 2, (-\infty, \infty)$
32. $(f \circ g)(x) = x + 2, (-\infty, \infty)$;
$(g \circ f)(x) = \sqrt[3]{x^3 + 2}, (-\infty, \infty)$;
$(f \circ f)(x) = x^9 + 6x^6 + 12x^3 + 10, (-\infty, \infty)$;
$(g \circ g)(x) = x^{1/9}, (-\infty, \infty)$
33. $(f \circ g)(x) = \dfrac{1}{2x+4}, x \neq -2$; $(g \circ f)(x) = \dfrac{2}{x} + 4, x \neq 0$;
$(f \circ f)(x) = x, x \neq 0$, $(g \circ g)(x) = 4x + 12, (-\infty, \infty)$
34. $(f \circ g)(x) = x - 3, [3, \infty)$;
$(g \circ f)(x) = \sqrt{x^2 - 3}, (-\infty, -\sqrt{3}] \cup [\sqrt{3}, \infty)$;
$(f \circ f)(x) = x^4, (-\infty, \infty)$;
$(g \circ g)(x) = \sqrt{\sqrt{x-3} - 3}, [12, \infty)$
35. $(f \circ g)(x) = |2x + 3|, (-\infty, \infty)$;
$(g \circ f)(x) = 2|x| + 3, (-\infty, \infty)$; $(f \circ f)(x) = |x|, (-\infty, \infty)$;
$(g \circ g)(x) = 4x + 9, (-\infty, \infty)$
36. $(f \circ g)(x) = |x + 4| - 4, (-\infty, \infty)$;
$(g \circ f)(x) = |x|, (-\infty, \infty)$; $(f \circ f)(x) = x - 8, (-\infty, \infty)$;
$(g \circ g)(x) = |x + 4| + 4, (-\infty, \infty)$
37. $(f \circ g)(x) = \dfrac{2x-1}{2x}, x \neq 0$;
$(g \circ f)(x) = \dfrac{2x}{x+1} - 1, x \neq -1$;
$(f \circ f)(x) = \dfrac{x}{2x+1}, x \neq -1, x \neq -\frac{1}{2}$;
$(g \circ g)(x) = 4x - 3, (-\infty, \infty)$
38. $(f \circ g)(x) = \dfrac{1}{\sqrt{x^2 - 4x}}, (-\infty, 0) \cup (4, \infty)$;
$(g \circ f)(x) = \dfrac{1}{x} - \dfrac{4}{\sqrt{x}}, (0, \infty)$; $(f \circ f)(x) = x^{1/4}, (0, \infty)$;
$(g \circ g)(x) = x^4 - 8x^3 + 12x^2 + 16x, (-\infty, \infty)$
39. $(f \circ g)(x) = \sqrt[12]{x}, [0, \infty)$; $(g \circ f)(x) = \sqrt[12]{x}, [0, \infty)$;
$(f \circ f)(x) = \sqrt[9]{x}, (-\infty, \infty)$; $(g \circ g)(x) = \sqrt[16]{x}, [0, \infty)$
40. $(f \circ g)(x) = \dfrac{2x+4}{x}, x \neq -2, x \neq 0$;
$(g \circ f)(x) = \dfrac{1}{1+x}, x \neq -1, x \neq 0$; $(f \circ f)(x) = x, x \neq 0$;
$(g \circ g)(x) = \dfrac{x}{3x+4}, x \neq -2, x \neq -\frac{4}{3}$
41. $(f \circ g \circ h)(x) = \sqrt{x-1} - 1$
42. $(f \circ g \circ h)(x) = \dfrac{1}{x^6 + 6x^4 + 12x^2 + 8}$
43. $(f \circ g \circ h)(x) = (\sqrt{x} - 5)^4 + 1$
44. $(f \circ g \circ h)(x) = \sqrt{\dfrac{\sqrt[3]{x}}{\sqrt[3]{x} - 1}}$ **45.** $g(x) = x - 9, f(x) = x^5$
46. $g(x) = \sqrt{x}, f(x) = x + 1$
47. $g(x) = x^2, f(x) = x/(x+4)$
48. $g(x) = x + 3, f(x) = 1/x$ **49.** $g(x) = 1 - x^3, f(x) = |x|$
50. $g(x) = \sqrt{x}, f(x) = \sqrt{1+x}$
51. $h(x) = x^2, g(x) = x + 1, f(x) = 1/x$
52. $h(x) = \sqrt{x}, g(x) = x - 1, f(x) = \sqrt[3]{x}$
53. $h(x) = \sqrt[3]{x}, g(x) = 4 + x, f(x) = x^9$
54. $h(x) = \sqrt{x}, g(x) = 3 + x, f(x) = 2/x^2$
55. $R(x) = 0.15x - 0.000002x^2$
56. $P(x) = 0.055x - 0.0000015x^2$ **57.** (a) $g(t) = 60t$
(b) $f(r) = \pi r^2$ (c) $(f \circ g)(t) = 3600\pi t^2$ **58.** (a) $f(t) = t$
(b) $g(r) = \frac{4}{3}\pi r^3$ (c) $(g \circ f)(t) = \frac{4}{3}\pi t^3$; the volume as a function of time **59.** $A(t) = 16\pi t^2$ **60.** (a) $f(x) = 0.80x$
(b) $g(x) = x - 50$ (c) $(f \circ g)(x) = 0.80x - 40$;
$(g \circ f)(x) = 0.80x - 50$; applying the 20% discount, then \$50 coupon ($g \circ f$) gives the lower price **61.** (a) $f(x) = 0.9x$
(b) $g(x) = x - 100$ (c) $f \circ g(x) = 0.9x - 90$,
$g \circ f(x) = 0.9x - 100$, $f \circ g$: first rebate, then discount,
$g \circ f$: first discount, then rebate, $g \circ f$ is the better deal
62. (a) $s = \sqrt{1 + d^2}$ (b) $d = 350t$
(c) $s(t) = \sqrt{1 + 122{,}500t^2}$

Section 3.5 ■ pages 239

1. No **2.** Yes **3.** Yes **4.** No **5.** No **6.** Yes **7.** Yes
8. Yes **9.** Yes **10.** No **11.** No **12.** Yes **13.** No
14. Yes **15.** No **16.** Yes **17.** (a) 2 (b) 3
18. (a) 5 (b) 4 **19.** 1 **20.** 1
31. $f^{-1}(x) = \frac{1}{2}(x-1)$ **32.** $f^{-1}(x) = 6 - x$
33. $f^{-1}(x) = \frac{1}{4}(x-7)$ **34.** $f^{-1}(x) = \frac{1}{5}(3-x)$
35. $f^{-1}(x) = 2x$ **36.** $f^{-1}(x) = 1/\sqrt{x}, x > 0$
37. $f^{-1}(x) = (1/x) - 2$
38. $f^{-1}(x) = \dfrac{-2(x+1)}{x-1}$
39. $f^{-1}(x) = (5x-1)/(2x+3)$
40. $f^{-1}(x) = \sqrt[3]{\frac{1}{4}(5-x)}$
41. $f^{-1}(x) = \frac{1}{5}(x^2 - 2), x \geq 0$
42. $f^{-1}(x) = \sqrt{x + \frac{1}{4}} - \frac{1}{2}, x \geq -\frac{1}{4}$
43. $f^{-1}(x) = \sqrt{4 - x}, x \leq 4$
44. $f^{-1}(x) = \frac{1}{2}(x^2 + 1), x \geq 0$
45. $f^{-1}(x) = (x-4)^3$ **46.** $f^{-1}(x) = \sqrt[3]{2 - \sqrt[5]{x}}$
47. $f^{-1}(x) = x^2 - 2x, x \geq 1$
48. $f^{-1}(x) = \sqrt{9 - x^2}, 0 \leq x \leq 3$ **49.** $f^{-1}(x) = \sqrt[4]{x}$
50. $f^{-1}(x) = \sqrt[3]{1 - x}$