9. $A = \frac{512}{3}$

11. $A = \frac{14}{3}$

13. $A = \frac{1}{6}$

15. (a) $\dfrac{64\pi}{3}$

(b) $\dfrac{128\pi}{3}$

(c) $\dfrac{64\pi}{3}$

(d) $\dfrac{160\pi}{3}$

17. (a) 64π **(b)** 48π **19.** $\dfrac{\pi}{2}$

21. (a) $\dfrac{512\pi}{15}$ **(b)** 64π

23. 50 in · lb $\approx$ 4.167 ft · lb

25. 104,000π ft · lb $\approx$ 163.4 ft · ton   **27.** 250 ft · lb

29. 72,800 lb (on side walls)
62,400 lb (on wall at deep end)
15,600 lb (on wall at shallow end)

31. 4992π lb   **33.** $(\bar{x}, \bar{y}) = \left(\dfrac{a}{5}, \dfrac{a}{5}\right)$

**35.** $(\bar{x}, \bar{y}) = \left(0, \dfrac{2a^2}{5}\right)$

37. $s = \displaystyle\int_0^{\sqrt{3}} \dfrac{4}{\sqrt{4 - x^2}}\, dx$ **39.** 15π

41. $\dfrac{4}{15}$ **43.** $\dfrac{32\pi}{105}$ **45.** $\dfrac{8}{15}(1 + 6\sqrt{3}) \approx 6.076$

Chapter 7

Section 7.1

1. (a) 125   **(b)** 9   **(c)** $\frac{1}{9}$ **(d)** $\frac{1}{3}$
3. (a) 5^5 **(b)** $\frac{1}{5}$ **(c)** $\frac{1}{5}$ **(d)** 2^2

5. (a) e^6 **(b)** e^{12} **(c)** $\dfrac{1}{e^6}$ **(d)** e^2

7. $x = 4$ **9.** $x = -2$ **11.** $x = 2$
13. $x = 16$ **15.** $x = -\frac{5}{2}$
17. $2.7182805 < e$

19.
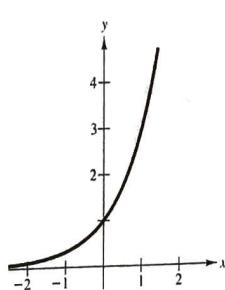
21.
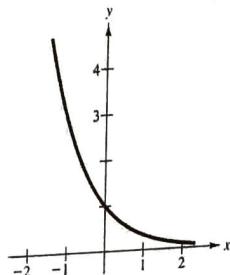
23.
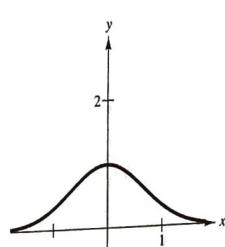
25.
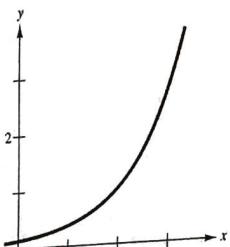
27.
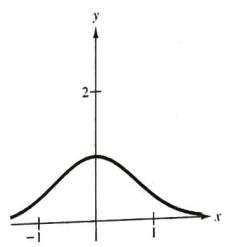
29. (a)
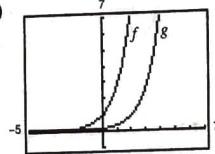
(b)
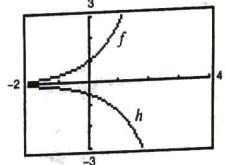
Translation two
units to the right

(c)
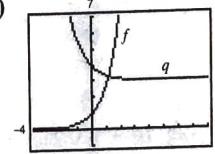
Reflection in the y-axis and a translation three
units upward

31. c   **32.** d   **33.** a   **34.** b
35. (a) \$2593.74   **(b)** \$2653.30   **(c)** \$2707.04
(d) \$2717.91   **(e)** \$2718.28
37. (a) \$88,692.04   **(b)** \$30,119.42
(c) \$9071.80   **(d)** \$247.88
39. (a) 0.154   **(b)** 0.487   **(c)** 0.811

41. (a) 850   **(b)**
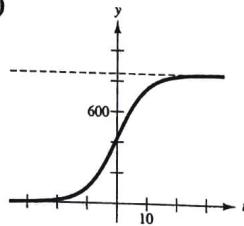
43. (a) 0.731   **(b)** 0.83

Section 7.2

1. 3   **3.** 1   **5.** −2

7. $2e^{2x}$ **9.** $2(x-1)e^{-2x+x^2}$ **11.** $-\dfrac{e^{1/x}}{x^2}$

13. $\dfrac{e^{\sqrt{x}}}{2\sqrt{x}}$ **15.** $e^{3x}(3x+4)$ **17.** $\dfrac{e^{x^2}(2x^2-1)}{x^2}$

19. $3(e^{-x}+e^x)^2(e^x-e^{-x})$ **21.** $\dfrac{-2(e^x-e^{-x})}{(e^x+e^{-x})^2}$

**23.** xe^x **25.** $\dfrac{10-e^y}{xe^y+3}$ **27.** $6(3e^{3x}+2e^{-2x})$

29. $32(x+1)e^{4x}$

31. Point of inflection: $(0, 1)$
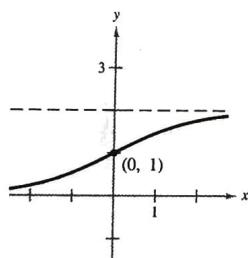
33. Relative minimum: $(0, 0)$
Relative maximum: $(2, 4e^{-2})$
Points of inflection: $(2 \pm \sqrt{2}, (6 \pm 4\sqrt{2})e^{-(2\pm\sqrt{2})})$
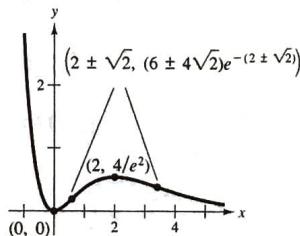
35. $y = x + 1$ **37.** $A = \sqrt{2}e^{-1/2}$

39.
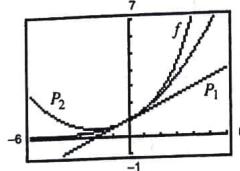
The values of f, P_1, P_2, and their first derivatives agree at $x = 0$. The values of the second derivatives of f and P_2 agree at $x = 0$.

41. (a)
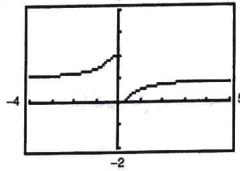
(b) When x increases without bound, $1/x$ approaches 0, and $e^{1/x}$ approaches 1. Therefore, $f(x)$ approaches $2/(1 + 1) = 1$. Thus, $f(x)$ has a horizontal asymptote at $y = 1$. As x approaches 0 from the right, $1/x$ approaches ∞, $e^{1/x}$ approaches ∞, and $f(x)$ approaches 0. As x approaches 0 from the left, $1/x$ approaches $-\infty$, $e^{1/x}$ approaches 0, and $f(x)$ approaches 2. The limit does not exist, because the left limit does not equal the right limit. Therefore, $x = 0$ is a nonremovable discontinuity.

43. $\dfrac{e^2 - 1}{2e^2}$ **45.** $\dfrac{e}{3}(e^2 - 1)$ **47.** $\dfrac{1}{1 + e^{-x}} + C$

49. $\dfrac{1}{2a}e^{ax^2} + C$ **51.** $\dfrac{e}{3}(e^2 - 1)$

53. $-\frac{1}{3}(1 + e^{-x})^3 + C$ **55.** $-\frac{2}{3}(1 - e^x)^{3/2} + C$

57. $2\sqrt{e^x - e^{-x}} + C$ **59.** $-\frac{5}{2}e^{-2x} + e^{-x} + C$

61. 4   **63.** $f(x) = \frac{1}{2}(e^x + e^{-x})$

65. $e^5 - 1 \approx 147.41$ **67.** $1 - e^{-1} \approx 0.632$

69. $\dfrac{\pi}{2}(e^2 - 1)$ **73. (a)** 0.212   **(b)** 0.035

75. 0.3413   **77. (a)** Midpoint Rule: 92.1898
Trapezoidal Rule: 93.8371
Simpson's Rule: 92.7385
(b) Midpoint Rule: 1.1906
Trapezoidal Rule: 1.1827
Simpson's Rule: 1.1880

Section 7.3

1.

3.

5.

7.
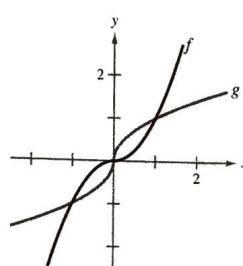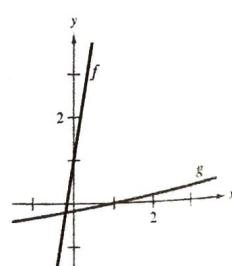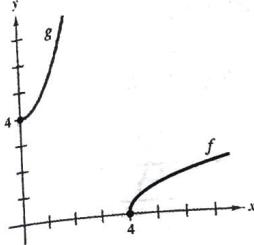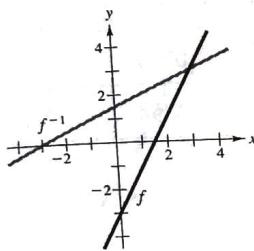
9. $f^{-1}(x) = \dfrac{x+3}{2}$

11. $f^{-1}(x) = x^{1/5}$

13. $f^{-1}(x) = x^2$, $x \geq 0$
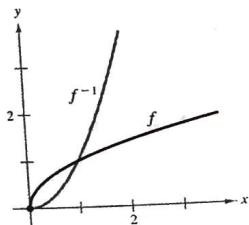
15. $f^{-1}(x) = \sqrt{4-x^2}$, $0 \leq x \leq 2$
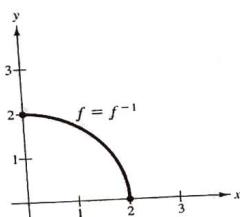

17. $f^{-1}(x) = x^3 + 1$
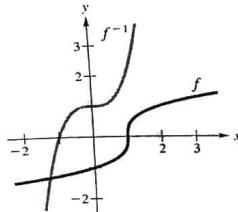
19. $f^{-1}(x) = x^{3/2}$, $x \geq 0$
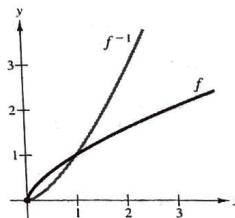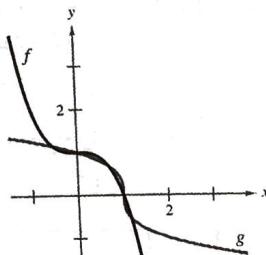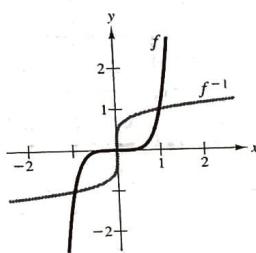

21. $f^{-1}(x) = \dfrac{\sqrt{7}x}{\sqrt{1-x^2}}$, $-1 < x < 1$
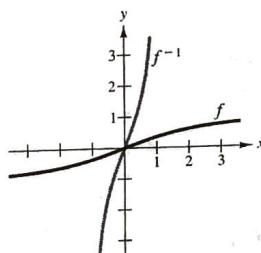
23. $f^{-1}(x) = \begin{cases} \dfrac{1 - \sqrt{1+16x^2}}{2x}, & \text{if } x \neq 0 \\ 0, & \text{if } x = 0 \end{cases}$
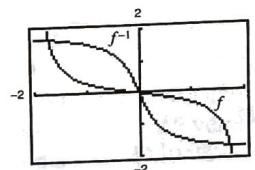
25.

x	1	2	3	4
$f^{-1}(x)$	0	1	2	4
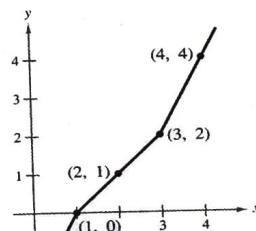
27. 32   **29.** 600   **31.** Inverse exists.
33. Inverse does not exist.   **35.** Inverse exists.
37. Inverse exists.   **39.** Inverse exists.
41. One-to-one   **43.** Not one-to-one
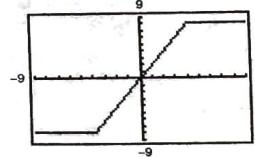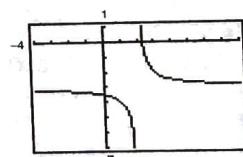
45. $f'(x) = 2(x-4) > 0$ on $(4, \infty)$
47. $f'(x) = -\dfrac{8}{x^3} < 0$ on $(0, \infty)$
49. $f'\left(\frac{1}{2}\right) = \frac{3}{4}$, $(f^{-1})'\left(\frac{1}{8}\right) = \frac{4}{3}$
51. $f'(5) = \frac{1}{2}$, $(f^{-1})'(1) = 2$
53. Not continuous at $x = 0$

Section 7.4

1. (a) $\log_2 8 = 3$ (b) $\log_3 \frac{1}{3} = -1$
3. (a) $10^{-2} = 0.01$ (b) $\left(\frac{1}{2}\right)^{-3} = 8$
5. (a) $e^{0.6931\cdots} = 2$ (b) $e^{2.128\cdots} = 8.4$
7. (a) $x = 3$ (b) $x = -1$
9. (a) $x = \frac{1}{3}$ (b) $x = \frac{1}{16}$
11. (a) $x = \frac{1}{9}$ (b) $x = 3$
13. (a) $x = -1, 2$ (b) $x = \frac{1}{3}$
15.
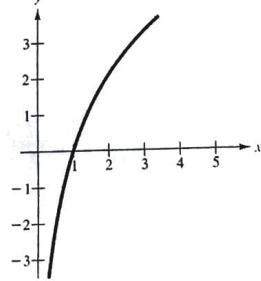
17.
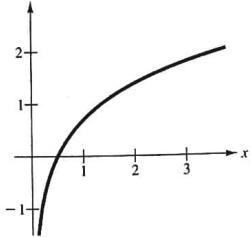
19.
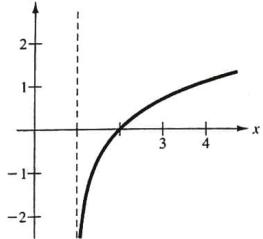
21.
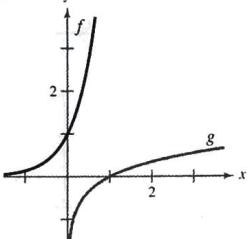
23.
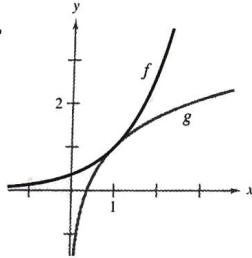
25. x^2 **27.** $5x + 2$ **29.** $\sqrt{x}$
31. (a) 1.7917   (b) -0.4055
(c) 4.3944   (d) 0.5493
33. $\ln 2 - \ln 3$ **35.** $\ln x + \ln y - \ln z$
37. $\frac{3}{2}\ln 2$ **39.** $3[\ln(x + 1) + \ln(x - 1) - 3\ln x]$
41. $\ln z + 2\ln(z - 1)$ **43.** $\ln \dfrac{x - 2}{x + 2}$
45. $\ln \sqrt[3]{\dfrac{x(x + 3)^2}{x^2 - 1}}$ **47.** $\ln \dfrac{9}{\sqrt{x^2 + 1}}$
49. $x = 4$ **51.** $x = 1$
53. $x = \ln 4 - 1 \approx 0.386$
55. $x = \dfrac{\ln 5 - \ln 6}{0.11} \approx -1.657$
57. $x = \dfrac{\ln 15}{\ln 25} \approx 0.841$ **59.** $t = \dfrac{\ln 2}{\ln 1.07} \approx 10.245$

61. (a) $t \approx 6.642$ years   (b) $t \approx 6.330$ years
(c) $t \approx 6.302$ years   (d) $t \approx 6.301$ years

63.

r	2%	4%	6%	8%	10%	12%
t (years)	54.93	27.47	18.31	13.73	10.99	9.16

65.

| x	y	$\dfrac{\ln x}{\ln y}$	$\ln \dfrac{x}{y}$	$\ln x - \ln y$
1	2	0	-0.6931	-0.6931
3	4	0.7925	-0.2877	-0.2877
10	5	1.4307	0.6931	0.6931
4	0.5	-2.000	2.0794	2.0794

67.
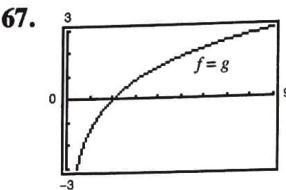
69. (a) 1.771   (b) 0.712
(c) -3.322 (d) -0.431

Section 7.5

1. 3   **3.** 2   **5.** $\dfrac{2}{x}$ **7.** $\dfrac{2(x^3 - 1)}{x(x^3 - 4)}$
9. $\dfrac{4(\ln x)^3}{x}$ **11.** $\dfrac{2x^2 - 1}{x(x^2 - 1)}$ **13.** $\dfrac{1 - x^2}{x(x^2 + 1)}$
15. $\dfrac{1 - 2\ln x}{x^3}$ **17.** $\dfrac{2}{x \ln x^2} = \dfrac{1}{x \ln x}$
19. $\dfrac{1}{1 - x^2}$ **21.** $\dfrac{-4}{x(x^2 + 4)}$ **23.** $\dfrac{\sqrt{x^2 + 1}}{x^2}$
25. $(\ln 4)4^x$ **27.** $(\ln 5)5^{x-2}$
29. $x2^x(x \ln 2 + 2)$ **31.** $\dfrac{1}{x(\ln 3)}$
33. $\dfrac{x - 2}{(\ln 2)x(x - 1)}$ **35.** $\dfrac{x}{(\ln 5)(x^2 - 1)}$
37. $\dfrac{2x}{x^2 - 1}$ **39.** $\dfrac{2x^2 - 1}{\sqrt{x^2 - 1}}$
41. $\dfrac{3x^3 - 15x^2 + 8x}{2(x - 1)^3\sqrt{3x - 2}}$
43. $\dfrac{(2x^2 + 2x - 1)\sqrt{x - 1}}{(x + 1)^{3/2}}$
45. $2(1 - \ln x)x^{(2/x)-2}$
47. $(x - 2)^{x+1}\left[\dfrac{x + 1}{x - 2} + \ln(x - 2)\right]$

49. $xy'' + y' = x\left(\dfrac{-2}{x^2}\right) + \dfrac{2}{x} = 0$ **51.** $\dfrac{2xy}{3 - 2y^2}$

53. $5x - y - 2 = 0$

55. Relative minimum: $\left(1, \frac{1}{2}\right)$
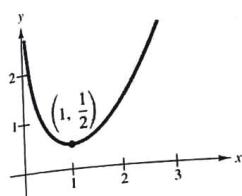
57. Relative minimum: $(e^{-1}, -e^{-1})$
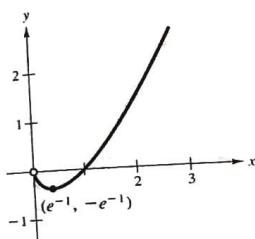

59. Relative minimum: (e, e)

Point of inflection: $\left(e^2, \dfrac{e^2}{2}\right)$
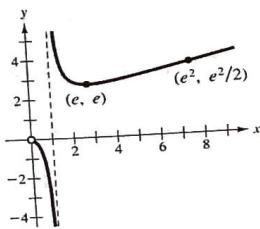
61. 0.567

63. (a) 0 (b) $L'(x) = \dfrac{1}{x}, \; L'(1) = 1$ (c) 2.718

65. (a) 0 (b) $-\sqrt{3}$

Section 7.6

1. $\ln|x + 1| + C$ **3.** $-\frac{1}{2}\ln|3 - 2x| + C$

5. $\ln\sqrt{x^2 + 1} + C$ **7.** $\dfrac{x^2}{2} - 4\ln|x| + C$

9. $\frac{1}{4}$ **11.** $\frac{7}{3}$ **13.** $-\ln 3$

15. $2\sqrt{x + 1} + C$

17. $\frac{1}{3}\ln|x^3 + 3x^2 + 9x| + C$

19. $3\ln|1 + x^{1/3}| + C$

21. $2[\sqrt{x} - \ln(1 + \sqrt{x})] + C$

23. $x + 6\sqrt{x} + 18\ln|\sqrt{x} - 3| + C$

25. $-\frac{2}{3}\ln|1 - x\sqrt{x}| + C$

27. $\ln|x - 1| + \dfrac{1}{2(x - 1)^2} + C$ **29.** $\dfrac{3^x}{\ln 3} + C$

31. $\dfrac{7}{\ln 4}$ **33.** $-\dfrac{1}{2\ln 5}5^{x^2} + C$

35. $x - \ln(e^x + 1) + C_1$ or $-\ln(1 + e^{-x}) + C_2$

37. $\frac{15}{2} + 8\ln 2 \approx 13.045$ square units

39. $\pi \ln 4$ **41.** $\dfrac{\pi}{4}(32\ln 4 - 3)$ **43.** $\dfrac{26}{\ln 3}$

45. $2000\ln\frac{3}{2} \approx 810.93$ ft · lb

47. $P(t) = 1000(12\ln|1 + 0.25t| + 1)$

$P(3) \approx 7715$

49. $\dfrac{10}{\ln 2}\ln\dfrac{4}{3} \approx 4.15$ min

Section 7.7

1. $y = \frac{1}{2}e^{0.4605t}$ **3.** $y = 0.6687e^{0.4024t}$

5. Time to double: 5.78 years

Amount after 10 years: \$3320.12

Amount after 25 years: \$20,085.54

7. Annual rate: 8.94%

Amount after 10 years: \$1833.67

Amount after 25 years: \$7009.86

9. Annual rate: 9.50%

Time to double: 7.30 years

Amount after 25 years: \$5375.51

11. (a) $N = 30(1 - e^{-0.0502t})$ (b) 36 days

13. (a) $S = 30e^{-1.7918/t}$ (b) 20,965 units

(c)
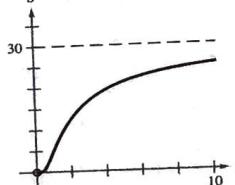
15. 900   **17.** 6015

19. Amount after 1000 years: 6.52 grams

Amount after 10,000 years: 0.14 gram

21. Initial quantity: 6.70 grams

Amount after 1000 years: 5.94 grams

23. Initial quantity: 2.16 grams

Amount after 10,000 years: 1.63 grams

25. 95.81%   **27.** 15,683 years   **29.** 22.35°

31. 11.75°   **33.** 527.06 mm Hg

Section 7.8

1. $\frac{1}{3}$ **3.** $\frac{5}{3}$ **5.** 3   **7.** 0   **9.** 2

11. $n = 1 : 0$, $n = 2 : \frac{1}{2}$, $n \geq 3 : \infty$ **13.** 0

15. $\frac{3}{2}$ **17.** ∞ **19.** 0   **21.** $-\frac{3}{2}$ **23.** 1

25. 0   **27.** 1   **29.** 1