### Chapter 5: Chapter Review Exercises, page 289

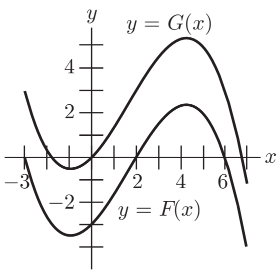
**1.** $29.92e^{-.2x}$ **2.** $P'(t) = .0533P(t)$ **3.** \$5488.12 **4.** $t \approx 11$ years **5.** .058 **6.** $t \approx 3850$ years old **7.** **(a)** $17e^{.018t}$ **(b)** 20.4 million **(c)** 2011 **8.** 7.85% **9.** **(a)** \$36,693 **(b)** The alternative investment is superior by \$3859. **10.** $t \approx 547$ minutes **11.** .02; 60,000 people per year; 5 million people **12.** 500,000 400,000 bacteria per hour **13.** a–F, b–D, c–A, d–G, e–H, f–C, g–B, h–E **14.** **(a)** 25 grams **(b)** 9 years **(c)** $t \approx 3$ years **(d)** $-15$ grams/year **(e)** 6 years **15.** 6% **16.** \$55.35 per year **17.** 400% **18.** $E(p) = \dfrac{2}{\dfrac{100}{p^2} - 1}$; $E(5) = 2/3 < 1$, inelastic **19.** 3%, decrease **20.** $-75\%$ **21.** increase **22.** $E(p) = pb$, $E(1/b) = 1$. **23.** $100(1 - e^{-.083t})$ **24.** $f(t) = 55/1 + 46.98e^{-.23t}$ **25.** **(a)** 400° **(b)** decreasing at a rate of 100°/sec **(c)** 17 sec **(d)** 2 sec **26.** $k = .05$, $P' = (.05)(15000) = 750$ bacteria per day.

## CHAPTER 6

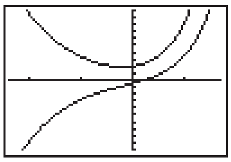
### Exercises 6.1, page 298

**1.** $(1/2)x^2 + C$ **3.** $(1/3)e^{3x} + C$ **5.** $3x + C$ **7.** $x^4 + C$ **9.** $7x + C$ **11.** $x^2/2c + C$ **13.** $2\ln|x| + x^2/4 + C$ **15.** $(2/5)x^{5/2} + C$ **17.** $(1/2)x^2 - (2/3)x^3 + \frac{1}{3}\ln|x| + C$ **19.** $-(3/2)e^{-2x} + C$ **21.** $ex + C$ **23.** $-e^{2x} - 2x + C$ **25.** $-5/2$ **27.** $1/2$ **29.** $-1/5$ **31.** $-1$ **33.** $1/15$ **35.** 3 **37.** $(2/5)t^{5/2} + C$ **39.** $C$ **41.** $-5/2e^{-.2x} + 5/2$ **43.** $x^2/2 + 3$ **45.** $(2/3)x^{3/2} + x - 28/3$ **47.** $2\ln|x| + 2$ **49.** Testing all three functions reveals that (b) is the only one that works.

**51.**




**53.** $1/4$ **55.** **(a)** $-16t^2 + 96t + 256$ **(b)** 8 sec **(c)** 400 ft **57.** $P(t) = 60t + t^2 - (1/12)t^3$ **59.** $20 - 25e^{-.4t}$ °C **61.** $-95 + 1.3x + .03x^2 - .0006x^3$ **63.** $5875(e^{.016t} - 1)$ **65.** $C(x) = 25x^2 + 1000x + 10{,}000$ **67.** $F(x) = \frac{1}{2}e^{2x} - e^{-x} + \frac{1}{6}x^3$



$[-2.4, 1.7]$ *by* $[-10, 10]$

### Exercises 6.2, page 306

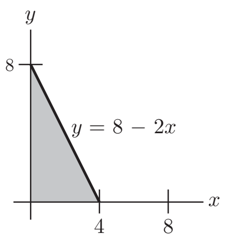
**1.** $F(x) = x^2 - (3/4)x, 1/4$ **3.** $F(t) = 2t^{3/2} + 2t^2,\ 44$ **5.** $F(x) = x^2/2 + 3/4x, 111/16$ **7.** $F(x) = -\frac{3}{20x^5} + \frac{1}{6x^3} - \frac{1}{x},\ \frac{59}{90}$ **9.** $F(t) = e^{3t} + \frac{t^2}{2}, \frac{1}{2} - \frac{1}{e^3}$ **11.** $F(x) = 2\ln|x|, 2\ln 2 = \ln 4$ **13.** $F(x) = \frac{e^{-2x}}{-2} + \frac{e^{-x}}{-1} - 7\frac{e^{-3x}}{-3}, -\frac{1}{e} - \frac{1}{2e^2} + \frac{7}{3e^3} - \frac{5}{6}$ **15.** $\int_0^4 f(x)\,dx = \int_0^1 f(x)\,dx + \int_1^4 f(x)\,dx = 8.5$ **17.** $2\int_1^3 f(x)\,dx - 3\int_1^3 g(x)\,dx = 9$ **19.** $\int_1^2 (-2x^3 + 4x^2 + 21)dx = \dfrac{137}{6}$ **21.** $\int_{-1}^1 (x^3 + x^2)\,dx = 2/3$ **23.** $f(3) - f(1) = \int_1^3 f'(x)\,dx = -2$ **25.** $f(1) - f(-1) = \int_{-1}^1 f'(t)dt = \dfrac{e^2 - e^{-2}}{2}$ **27.** $\int_0^2 f(x)dx = \int_0^1 f(x)dx + \int_1^2 f(x)dx = \dfrac{5}{2}$ **29.** $\int_{-1}^0 (1 + t)\,dt + \int_0^1 (1 - t)\,dt = 1$ **31.** $s(4) - s(2) = \int_2^4 (-32t)dt = -192$. The ball moved 192 ft downward in the interval $2 \le t \le 4$. **33.** **(a)** $s(3) - s(1) = \int_1^3 v(t)dt = 22$. In the interval of time $1 \le t \le 3$, the ball moved 22 ft in the upward direction. Thus at time $t = 3$, the ball is 22 ft higher than its position at $t = 1$. **(b)** $s(5) - s(1) = \int_1^5 v(t)dt = -84$. In the interval of time $1 \le t \le 5$, the ball moved 84 ft in the downward direction. Thus at time $t = 5$, the ball is 84 ft lower than its position at $t = 1$. **35.** **(a)** $C(3) - C(1) = \int_1^3 C'(x)\,dx = \int_1^3 (.1x^2 - x + 12)\,dx = 20.87$ dollars.

**(b)** $C(3) = C(1) + (C(3) - C(1)) = 15 + 20.87 = 35.87$ dollars. **37.** $\int_0^{10} (700e^{.07t} + 1000)\,dt = 20{,}137.5$ dollars

**39.** **(a)** $P(10) - P(0) = \int_0^{10} \left(\frac{7}{300}e^{t/25} - \frac{e^{t/16}}{80}\right) dt = \frac{1}{60}\left(-23 + 35e^{2/5} - 12e^{5/8}\right) \approx .11325$ million or 113,250 people. **(b)** $P(40) - P(10) = \int_{10}^{40} \left(\frac{7}{300}e^{t/25} - \frac{e^{t/16}}{80}\right) dt = \frac{7}{12}e^{2/5}\left(-1 + e^{6/5}\right) + \frac{1}{5}\left(e^{5/8} - e^{5/2}\right) \approx -.043812$ million or $-43{,}812$ people. Between 2000 and 2010, the population increased by 113,250 people. Between 2010 and 2040, the population decreased by 43,812 people, due to emigration. **41.** $P(t) = 337.023 - 137.023e^{.03t}$ thousand dollars **43.** $-\int_0^2 \left(t + \frac{1}{2}\right) dt = -3$ grams per minute. 3 grams of salt were eliminated the first two minutes.

### Exercises 6.3, page 315

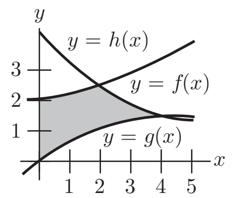
**1.** **(a)** $3 \times 2 = 6$, **(b)** $\int_1^4 2\,dx = 6$ **3.** **(a)** $1/2 \times 2 \times 2 = 2$, **(b)** $\int_{-2}^0 -x\,dx = 2$ **5.** **(a)** $1/2 + 1/2 = 1$, **(b)** $\int_0^1 (1 - x)\,dx + \int_1^2 (x - 1)\,dx = 1$ **7.** $\int_1^2 \frac{1}{x}\,dx$ **9.** $\int_1^2 \ln x\,dx$ **11.** $\int_1^3 (x + 1/x)dx$ **13.** $\ln 2$ **15.** $4 + \ln 3$ **17.**



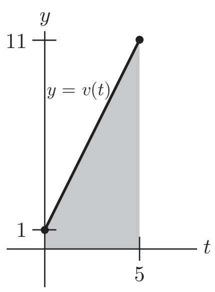

**19.** 10 **21.** $-5/2 + 4e^{1/2}$ **23.** $33/5$ **25.** $(1/4)b^4 = 4$, $b = 2$ **27.** .5; .25, .75, 1.25, 1.75 **29.** .6; 1.3, 1.9, 2.5, 3.1, 3.7 **31.** 8.625 **33.** 15.12 **35.** .077278 **37.** 40 **39.** 15 **41.** 5.625; 4.5 **43.** 1.61321; error = .04241 **45.** $A \approx (20)(106) + (40)(101) + (40)(100) + (40)(113) + (20)(113) = 16{,}940$ sq. ft. **49.** 1.494 **51.** 9.6

### Exercises 6.4, page 328

**1.** $\int_1^2 f(x)\,dx + \int_3^4 -f(x)\,dx$ **3.**




**5.** Positive **7.** 4 **9.** 22/3 **11.** $3\ln 3 - 2$ **13.** 64/3 **15.** 52/3 **17.** $e^2 - e - 1/2$ **19.** 1/6 **21.** 32/3 **23.** 1/2 **25.** 1/24 **27.** **(a)** 9/2 **(b)** 19/3 **(c)** 79/6 **29.** 3/2 **31.** **(a)** 30 ft **(b)**




**33.** **(a)** \$1185.75 **(b)** The area under the marginal cost curve from $x = 2$ to $x = 8$. **35.** The increase in profits resulting from increasing the production level from 44 to 48 units **37.** **(a)** $368/15 \approx 24.5$ **(b)** The amount the temperature falls during the first 2 h **39.** 2088 million $m^3$ **41.** About 4.48 billion barrels. **43.** $A$ is the difference between the two heights after 10 seconds. **45.** **(a)** 15/2 ft **(b)** $\int_0^{1/2} v(t)\,dt - \int_{1/2}^1 v(t)\,dt + \int_1^3 v(t)\,dt = 91/12$ ft **47.** $A \approx 3.9100$ **49.** $A \approx 2.2676$

### Exercises 6.5, page 337

**1.** 3 **3.** $50(1 - e^{-2})$ **5.** $\frac{3}{4}\ln 3$ **7.** 55° **9.** ≈82 g **11.** \$20 **13.** \$404.72 **15.** \$200 **17.** \$25 **19.** Intersection (100, 10), consumers' surplus = \$100, producers' surplus = \$250 **21.** \$3236.68 **23.** \$75,426 **25.** 13.35 years **27.** **(b)** $1000e^{-.04t_1}\Delta t + 1000e^{-.04t_2}\Delta t + \cdots + 1000e^{-.04t_n}\Delta t$ **(c)** $f(t) = 1000e^{-.04t}; 0 \le t \le 5$ **(d)** $\int_0^5 1000e^{-.04t}dt$ **(e)** \$4531.73 **29.** $(32/3)\pi$ **31.** $31\pi/5$ **33.** $8\pi$ **35.** $13\pi/3$ **37.** $n = 4$, $b = 10$, $f(x) = x^3$ **39.** $n = 3$, $b = 7$, $f(x) = x + e^x$ **41.** The sum is approximated by $\int_0^3 (3 - x)^2\,dx = 9$. **43.** **(a)** $(1000/3r)(e^{3r} - 1)$ **(b)** 4.5% **45.** **(a)** $(1000/r)(e^{6r} - 1)$ **(b)** 5%

### Chapter 6: Answers to Fundamental Concept Check Exercises, page 343

**1.** To antidifferentiate a function $f(x)$ means to find a function $F(x)$ such that $F'(x) = f(x)$. **2. (a)** $\frac{1}{r+1}x^{r+1} + C$ **(b)** $\frac{1}{k}e^{kx} + C$ **(c)** $\ln|x| + C$ **(d)** $\int f(x)dx + \int g(x)dx$ **(e)** $k\int f(x)dx$ **3.** $a$ denotes the left endpoint of the interval, $b$ the right endpoint, $n$ the number of subintervals in the Riemann sum, and $\Delta x$ the length of one subinterval. **4.** Suppose $f(x) \geq 0$. To approximate the integral $\int_a^b f(x)dx$, which represents the area under the graph of $f$, above the $x$-axis, from $a$ to $b$, we can use rectangles of equal width and height $f(x_i)$. Each rectangle has area $f(x_i)\Delta x$. The sum of the areas of the rectangles is the Riemann sum $f(x_1)\Delta x + f(x_2)\Delta x + \cdots + f(x_n)\Delta x$, which approximates the area of the region under the graph of $f$. **5.** The area under the rate of change function $f(x)$ is equal to the net change in the function $F(x)$. For example, the area under the velocity function $v(t)$ from $a$ to $b$ is equal to the net change in position, or $s(b) - s(a)$. **6.** The definite integral is of the form $\int_a^b f(x)dx = F(b) - F(a)$, where $F$ is any antiderivative of $f$. **7.** An indefinite integral is of the form $\int f(x)dx = F(x) + C$. It is the family of antiderivatives of $f$. A definite integral is of the form $\int_a^b f(x)dx = F(b) - F(a)$. It is a number. **8.** The fundamental theorem of calculus: Suppose $f$ is a continuous function on $[a, b]$. The Riemann sums of $f$ on $[a, b]$ approach the value of the definite integral $\int_a^b f(x)dx = F(b) - F(a)$, as the number of partitions of the interval $[a, b]$ increase indefinitely. **9.** $F(x)\Big|_a^b = F(b) - F(a)$ is the value of the definite integral of $f$ on $[a, b]$. **10.** The area of the region bounded by the graph of $y = f(x)$ on top, the graph of $y = g(x)$ at the bottom; from $x = a$ to $x = b$ is given by $\int_a^b [f(x) - g(x)]dx$. If the limits $a$ and $b$ are not given, we determine them by finding the first coordinates of the points of intersection of the graphs of $f$ and $g$. **11. (a)** $\dfrac{1}{b-a}\displaystyle\int_a^b f(x)dx$ **(b)** The consumers' surplus for a commodity having demand curve $p = f(x)$ is

$$\int_0^A [f(x) - B]dx,$$

where the quantity demanded is $A$ and the price is $B = f(A)$. **(c)** The future value of a continuous income stream of $K$ dollars per year for $N$ years at interest rate $r$ compounded continuously is

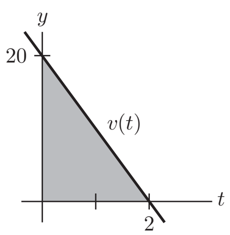
$$\int_0^N Ke^{r(N-t)}\,dt.$$

**(d)** $\pi\displaystyle\int_a^b [f(x)]^2\,dx$

### Chapter 6: Chapter Review Exercises, page 343

**1.** $9x + C$ **2.** $(1/3)x^3 - (3/2)x^2 + 2x + C$ **3.** $2/3(x+1)^{3/2} + C$ **4.** $2\ln|x+4| + C$ **5.** $2((1/4)x^4 + x^3 - x) + C$ **6.** $5/6(x+3)^{6/5} + C$ **7.** $-2e^{-x/2} + C$ **8.** $10\sqrt{x-7} + C$ **9.** $(3/5)x^5 - x^4 + C$ **10.** $(1/16)(2x+3)^8 + C$ **11.** $-2/3(4-x)^{3/2} + C$ **12.** $5\ln|x| - x^2/10 + C$ **13.** $8/3$ **14.** $3/64$ **15.** $(14/3)\sqrt{2}$ **16.** $2\ln 16/5$ **17.** $15/16$ **18.** $104/9$ **19.** $3/4$ **20.** $3(e-1)$ **21.** $\frac{1}{3}\ln 4$ **22.** $(1/2)(e^6 - e^{-6})$ **23.** $1/2$ **24.** $7/6$ **25.** $80/81$ **26.** $2 + e - 3/e$ **27.** $5/32$ **28.** $76/3$ **29.** $1/3$ **30.** $4$ **31.** $1/2$ **32.** $\approx .370$ **33.** $28/3$ **34.** $(39/16) - \ln 4$ **35.** $(e/2) - 1$ **36.** $253/12$ **37.** $8$ **38.** $3$ **39.** $(1/3)(x-5)^3 - 7$ **40.** $(6/5) - (1/5)e^{-5x}$ **41. (a)** $2t^2 + C$ **(b)** $Ce^{4t}$ **(c)** $(1/4)e^{4t} + C$ **43.** $.02x^2 + 150x + 500$ dollars **44.** loss of \$3000 **45.** The total quantity of drug (in cubic centimeters) injected during the first 4 min

**46. (a)** 20.4 meters **(b)**




**47.** 25 **48.** 17 **49.** .68571; .69315 **50.** $\approx 3.17333$; 3.19453 **51.** \$433.33 **52.** $\approx$ \$3688.69 **53.** 15 **54.** $\displaystyle\int_0^1 3e^{-x}\,dx = 3(1 - e^{-1})$ **55.** .26; 1.96 **56.** $8\pi/15$ **57. (a)** $f(t) = Q - (Q/A)t$ **(b)** $Q/2$ **58. (a)** $Q - (rt^2/2)$ **(b)** $r = 2Q/A^2$, **(c)** $(2/3)Q$

**59. (a)** The area under the curve $y = (1/1 + t^2)$ from $t = 0$ to $t = 3$. **(b)** $(1/1 + x^2)$ **60. (a)** $h(0)$ is the area under one quarter of the unit circle. $h(1)$ is the area under one half of the unit circle. **(b)** $h'(x) = \sqrt{1 - x^2}$ **62.** $e - 1$ **63.** $15/4$ **64.** 4 **65.** True **66. (a)** $(20 - 4t_1)\Delta t$ **(b)** Let $R(t)$ = amount of water added up to time $t$. Then, $R'(t) = r(t)$, and so, $\int_0^5 r(t)\,\mathrm{dt} = R(5) - R(0)$ = total amount of water added from $t = 0$ to $t = 5$. **67.** 65,687 $\text{km}^3$ **68.** \$4,708.71 **69.** $f(x) = x^3 - x^2 + x$ **70.** $a = \sqrt[3]{6}$