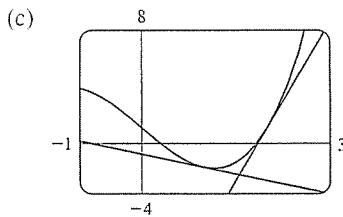


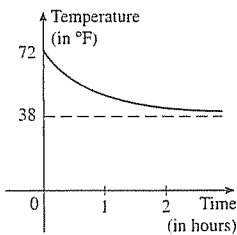
7.  $y = 10x + 13$     9.  $y = \frac{1}{4}x + \frac{3}{4}$   
 11. (a)  $-2/(a+3)^2$     (b) (i)  $-\frac{1}{2}$     (ii)  $-\frac{2}{9}$     (iii)  $-\frac{1}{8}$   
 13. (a)  $3a^2 - 4$     (b)  $y = -x - 1, y = 8x - 15$



15. (a) 0    (b) C    (c) Speeding up, slowing down, neither  
 (d) The car stopped.

17.  $-24 \text{ ft/s}$     19.  $12a^2 + 6, 18 \text{ m/s}, 54 \text{ m/s}, 114 \text{ m/s}$

21. Greater (in magnitude)



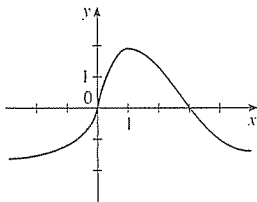
23. (a) (i)  $-1.2 \text{ °C/h}$     (ii)  $-1.25 \text{ °C/h}$     (iii)  $-1.3 \text{ °C/h}$   
 (b)  $-1.9 \text{ °C/h}$   
 25. (a) (i)  $\$20.25/\text{unit}$     (ii)  $\$20.05/\text{unit}$     (b)  $\$20/\text{unit}$

Exercises 2.8 □ page 161

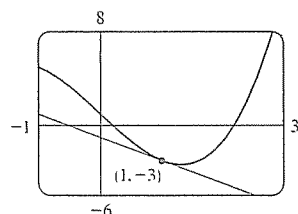
1. The line from  $(2, f(2))$  to  $(2+h, f(2+h))$

3.  $g'(0), 0, g'(4), g'(2), g'(-2)$

5.    7. 7;  $y = 7x - 12$



9. (a)  $-2; y = -2x - 1$     (b)



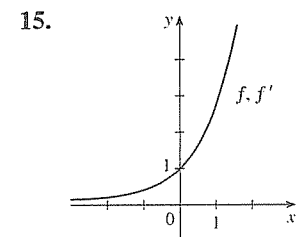
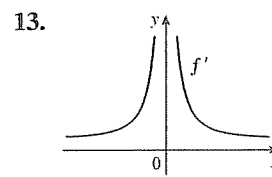
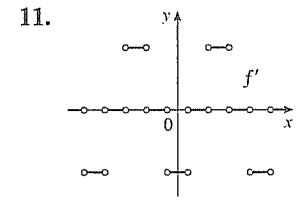
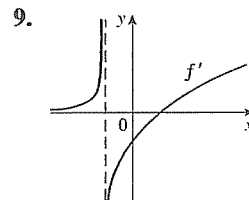
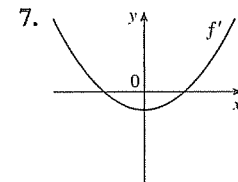
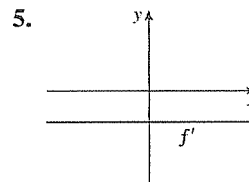
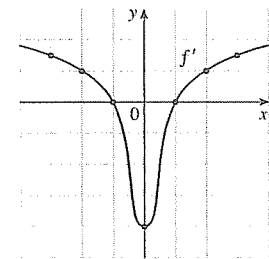
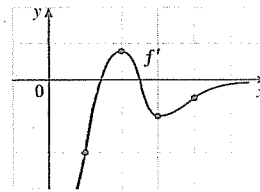
11. 3.296    13.  $1 - 4a$     15.  $-1/(2a - 1)^2$   
 17.  $1/(3 - a)^{3/2}$     19.  $f(x) = \sqrt{x}, a = 1$   
 21.  $f(x) = x^9, a = 1$     23.  $f(x) = \sin x, a = \pi/2$

25.  $-2 \text{ m/s}$   
 27. (a) The rate at which the cost is changing per ounce of gold produced; dollars per ounce  
 (b) When the 800th ounce of gold is produced, the cost of production is  $\$17/\text{oz}$ .

- (c) Decrease in the short term; increase in the long term  
 29. (a) The rate at which the fuel consumption is changing with respect to speed;  $(\text{gal/h})/(\text{mi/h})$   
 (b) The fuel consumption is decreasing by  $0.05 (\text{gal/h})/(\text{mi/h})$  as the car's speed reaches  $20 \text{ mi/h}$ .  
 31. The rate at which the cash per capita in circulation is changing in dollars per year;  $\$39.90/\text{yr}$   
 33. Does not exist

Exercises 2.9 □ page 171

1. (a)  $-2$     (b)  $0.8$     3. (a) 2    (b) 1    (c) 0  
 (c)  $-1$     (d)  $-0.5$     (d)  $-3$     (e) 0    (f) 1    (g) 2



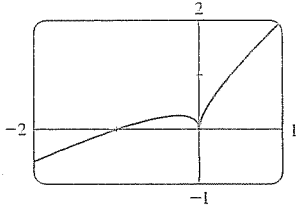
$f'(x) = e^x$

17. (a) 0, 1, 2, 4    (b)  $-1, -2, -4$     (c)  $f'(x) = 2x$   
 19.  $f'(x) = 5, \mathbb{R}, \mathbb{R}$     21.  $f'(x) = 3x^2 - 2x + 2, \mathbb{R}, \mathbb{R}$   
 23.  $g'(x) = 1/\sqrt{1+2x}, [-\frac{1}{2}, \infty), (-\frac{1}{2}, \infty)$   
 25.  $G'(x) = -10/(2+x)^2, \{x|x \neq -2\}, \{x|x \neq -2\}$   
 27.  $f'(x) = 4x^3, \mathbb{R}, \mathbb{R}$     29. (a)  $f'(x) = 1 + 2/x^2$   
 31. (a) The rate at which the unemployment rate is changing, in percent unemployed per year

(b)

$t$	$U'(t)$	$t$	$U'(t)$
1988	-0.20	1993	-0.70
1989	0.05	1994	-0.65
1990	0.75	1995	-0.35
1991	0.95	1996	-0.35
1992	0.05	1997	-0.50

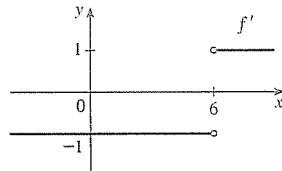
33. 4 (discontinuity); 8 (corner); -1, 11 (vertical tangents)  
 35.



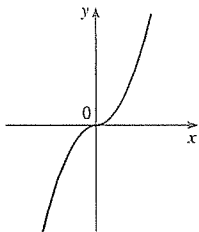
Differentiable at -1;  
 not differentiable at 0

37. (a)  $\frac{1}{3}a^{-2/3}$

39.  $f'(x) = \begin{cases} -1 & \text{if } x < 6 \\ 1 & \text{if } x > 6 \end{cases}$   
 or  $f'(x) = \frac{x-6}{|x-6|}$



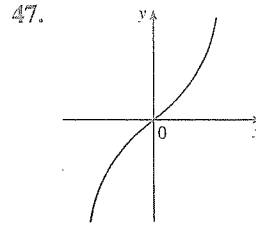
41. (a)



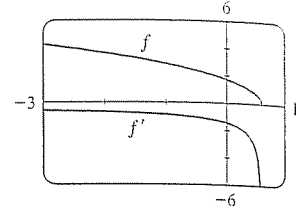
- (b) All  $x$   
 (c)  $f'(x) = 2|x|$

45.  $63^\circ$

45. (a) The rate at which the cost changes with respect to the interest rate; dollars/(percent per year)  
 (b) As the interest rate increases past 10%, the cost is increasing at a rate of \$1200/(percent per year).  
 (c) Always positive



49. (a)  $f'(x) = -\frac{5}{2}(3-5x)^{-1/2}$   
 (b)  $(-\infty, \frac{3}{5}]$ ,  $(-\infty, \frac{3}{5})$   
 (c)



51. -4 (discontinuity), -1 (corner), 2 (discontinuity), 5 (vertical tangent)  
 53. 0.09 (or any smaller positive number)    55. 0

**Problems Plus □ page 179**

1.  $\frac{2}{3}$     3. -4    5. 1    7.  $a = \frac{1}{2} \pm \frac{1}{2}\sqrt{5}$     9.  $\frac{3}{4}$   
 11. (b) Yes    (c) Yes; no  
 13. (a) 0    (b) 1    (c)  $f'(x) = x^2 + 1$

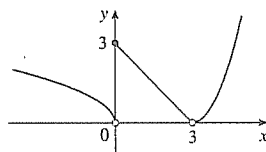
**Chapter 2 Review □ page 174**

**True-False Quiz**

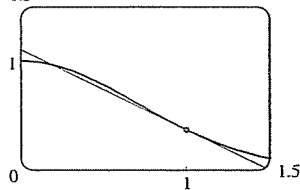
1. False    3. True    5. False    7. True    9. False  
 11. True    13. True    15. False

**Exercises**

1. (a) (i) 3    (ii) 0    (iii) Does not exist    (iv) 2    (v)  $\infty$   
 (vi)  $-\infty$     (vii) 4    (viii) -1    (b)  $y = 4$ ,  $y = -1$   
 (c)  $x = 0$ ,  $x = 2$     (d) -3, 0, 2, 4  
 3. 0    5. 2    7. 0    9.  $\infty$     11.  $-\frac{1}{8}$     13. -1  
 15. 0    17.  $-\frac{1}{2}$     19.  $\frac{1}{2}$     21. 0  
 23.  $x = 0$ ,  $y = 0$     25. 1  
 31. (a) (i) 3    (ii) 0    (iii) Does not exist    (iv) 0    (v) 0  
 (vi) 0    (b) At 0 and 3    (c)



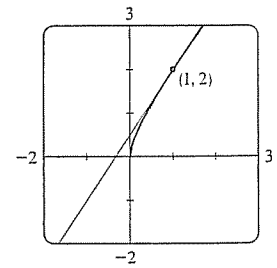
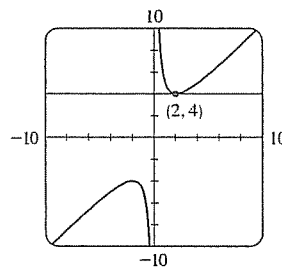
33.  $\mathbb{R}$     37. (a) -8    (b)  $y = -8x + 17$   
 39. (a) (i) 3 m/s    (ii) 2.75 m/s    (iii) 2.625 m/s  
 (iv) 2.525 m/s    (b) 2.5 m/s  
 41.  $f''(5)$ , 0,  $f'(5)$ ,  $f'(2)$ , 1,  $f'(3)$   
 43. (a) -0.736    (b)  $y \approx -0.736x + 1.104$   
 (c) 1.5



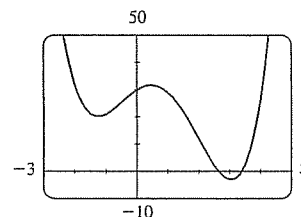
**Chapter 3**

**Exercises 3.1 □ page 189**

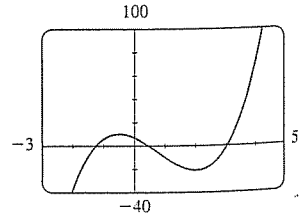
1. (a) See Definition of the Number  $e$  (page 187).  
 (b) 0.99, 1.03;  $2.7 < e < 2.8$   
 3.  $f'(x) = 5$     5.  $f'(x) = 2x + 3$     7.  $y' = -\frac{2}{3}x^{-7/5}$   
 9.  $V'(r) = 4\pi r^2$     11.  $Y'(t) = -54t^{-10}$   
 13.  $F'(x) = 12,288x^2$     15.  $g'(x) = 2x - (2/x^3)$   
 17.  $y' = \frac{3}{2}\sqrt{x} + (2/\sqrt{x}) - 3/(2x\sqrt{x})$   
 19.  $y' = 3 + 2e^x$     21. 0    23.  $y' = 2ax + b$   
 25.  $y' = 1 + 2/(5\sqrt[3]{x^3})$     27.  $v' = \frac{3}{2}\sqrt{x} - 5/(2x^3\sqrt{x})$   
 29.  $4x - 4x^3$     31.  $45x^{14} - 15x^2$     33.  $1 - x^{-2/3}$   
 35. (a) 0.264    (b)  $2^{2/5}/5 \approx 0.263902$   
 37.  $y = 4$     39.  $y = \frac{3}{2}x + \frac{1}{2}$



41. (a)

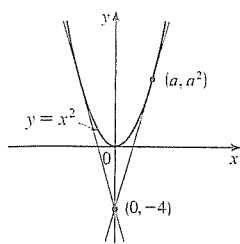


- (c)  $4x^3 - 9x^2 - 12x + 7$

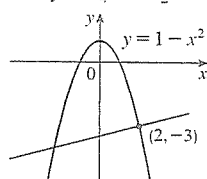


43.  $(1, 0)$ ,  $(-\frac{1}{3}, \frac{32}{27})$

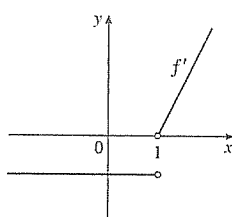
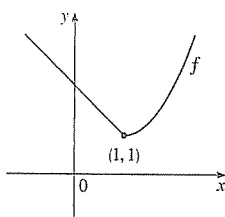
47.  $(\pm 2, 4)$



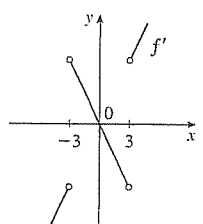
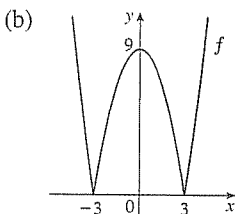
49.  $y = \frac{1}{4}x - \frac{7}{2}$



53. No



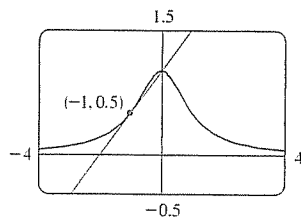
55. (a) Not differentiable at 3 or -3;  $f'(x) = \begin{cases} 2x & \text{if } |x| > 3 \\ -2x & \text{if } |x| < 3 \end{cases}$



57.  $a = -\frac{1}{2}, b = 2$     59.  $y = \frac{3}{16}x^3 - \frac{9}{4}x + 3$     61. 1000

Exercises 3.2 □ page 195

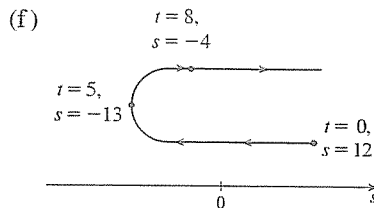
1.  $y' = 5x^4 + 3x^2 + 2x$     3.  $f'(x) = x(x + 2)e^x$   
 5.  $y' = (x - 2)e^x/x^3$     7.  $h'(x) = -3/(x - 1)^2$   
 9.  $G'(s) = (2s + 1)(s^2 + 2) + (s^2 + s + 1)(2s)$   
 $[= 4s^3 + 3s^2 + 6s + 2]$   
 11.  $H'(x) = 1 + x^{-2} + 2x^{-3} - 6x^{-4}$   
 13.  $y' = (-3t^2 + 14t + 23)/(t^2 + 5t - 4)^2$   
 15.  $y' = \frac{3}{2}\sqrt{x} + (2/\sqrt{x}) - 3/(2x\sqrt{x})$     17.  $y' = (r^2 - 2)e^r$   
 19.  $y' = -(4x^3 + 2x)/(x^4 + x^2 + 1)^2$   
 21.  $f'(x) = 2cx/(x^2 + c)^2$     23.  $y = \frac{1}{2}x + \frac{1}{2}$     25.  $y = 2x$   
 27. (a)  $y = \frac{1}{2}x + 1$     (b)



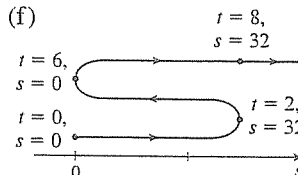
29. (a)  $(x^3 - 3x^2)e^x/x^6 [= e^x(x^{-3} - 3x^{-4})]$   
 31. (a) -16    (b)  $-\frac{20}{9}$     (c) 20    33. 7  
 35. (a) 0    (b)  $-\frac{2}{3}$     37. \$7.322 billion per year  
 39. Two,  $(-2 \pm \sqrt{3}, (1 \mp \sqrt{3})/2)$     41. (c)  $3e^{3x}$

Exercises 3.3 □ page 205

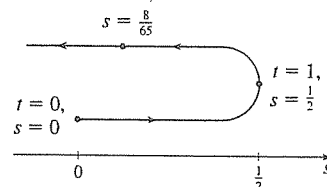
1. (a)  $2t - 10$     (b)  $-4$  ft/s    (c)  $t = 5$   
 (d)  $t > 5$     (e) 34 ft



3. (a)  $3t^2 - 24t + 36$     (b)  $-9$  ft/s    (c)  $t = 2, 6$   
 (d)  $0 \leq t < 2, t > 6$     (e) 96 ft    (f)



5. (a)  $(1 - t^2)/(t^2 + 1)^2$     (b)  $-\frac{3}{25}$  ft/s    (c)  $t = 1$   
 (d)  $0 \leq t < 1$     (e)  $\frac{13}{17}$  ft    (f)

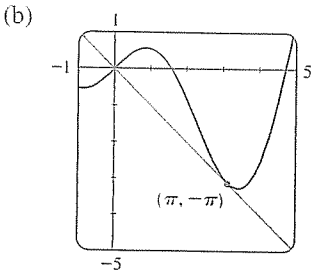


7.  $t = 4$  s  
 9. (a)  $30 \text{ mm}^2/\text{mm}$ ; the rate at which the area is increasing with respect to side length as  $x$  reaches 15 mm  
 (b)  $\Delta A \approx 2x \Delta x$   
 11. (a) (i)  $5\pi$     (ii)  $4.5\pi$     (iii)  $4.1\pi$   
 (b)  $4\pi$     (c)  $\Delta A \approx 2\pi r \Delta r$   
 13. (a)  $8\pi \text{ ft}^2/\text{ft}$     (b)  $16\pi \text{ ft}^2/\text{ft}$   
 (c)  $24\pi \text{ ft}^2/\text{ft}$  The rate increases as the radius increases.  
 15. (a) 6 kg/m    (b) 12 kg/m  
 (c) 18 kg/m; At the right end; at the left end  
 17. (a) 4.75 A    (b) 5 A;  $t = \frac{2}{3}$  s  
 19. (a)  $dV/dP = -C/P^2$     (b) At the beginning  
 21. (a) 16 million/year; 80 million/year  
 (b)  $P = at^3 + bt^2 + ct + d$ , where  $a = 2325.67$ ,  
 $b = -1.306488 \times 10^7$ ,  $c = 2.44631 \times 10^{10}$ , and  
 $d = -1.52658 \times 10^{13}$   
 (c)  $P'(t) = 3at^2 + 2bt + c$     (d) 14.0 million/year (smaller);  
 78.8 million/year (smaller)    (e) 86.5 million/year  
 23. (a)  $a^2k/(akt + 1)^2$     (c) It approaches  $a$  moles/L.  
 (d) It approaches 0.    (e) The reaction virtually stops.  
 25. (a) 0.926 cm/s; 0.694 cm/s; 0  
 (b) 0;  $-92.6 \text{ (cm/s)/cm}$ ;  $-185.2 \text{ (cm/s)/cm}$   
 (c) At the center; at the edge  
 27. (a)  $C'(x) = 3 + 0.02x + 0.0006x^2$     (b) \$11/yd, the rate at which the cost is changing as the 100th pair of jeans is being produced    (c) \$11.07/pair  
 29. (a)  $[xp'(x) - p(x)]/x^2$ ; the average productivity increases as new workers are added.  
 31.  $-0.2436 \text{ K/min}$   
 33. (a) 0 and 0    (b)  $C = 0$   
 (c) (0, 0), (500, 50); it is possible for the species to coexist.

Exercises 3.4 □ page 213

1.  $1 - 3 \cos x$     3.  $\cos x - \sin x$     5.  $3t^2 \cos t - t^3 \sin t$   
 7.  $-\csc \theta \cot \theta + e^\theta (\cot \theta - \csc^2 \theta)$

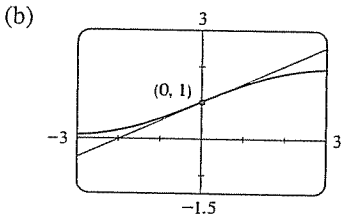
9.  $(x \sec^2 x - \tan x)/x^2$   
 11.  $(\sin x + \cos x + x \sin x - x \cos x)/(1 + \sin 2x)$   
 13.  $(x \cos x - 2 \sin x)/x^3$  15.  $-\csc x \cot^2 x - \csc^3 x$   
 21.  $y = 2x + 1 - \pi/2$  23.  $y = x + 1$   
 25. (a)  $y = -x$



27. (a)  $2 - \csc^2 x$  29.  $(2n + 1)\pi \pm \pi/3, n$  an integer  
 31. (a)  $8 \cos t$  (b)  $4\sqrt{3}, -4$ ; to the left 33. 5 ft/rad  
 35. 5 37.  $\sin 1$  39. 0 41.  $\frac{1}{2}$  43.  $\frac{1}{2}$   
 45. (a)  $\sec^2 x = 1/\cos^2 x$  (b)  $\sec x \tan x = (\sin x)/\cos^2 x$   
 (c)  $\cos x - \sin x = (\cot x - 1)/\csc x$  47. 1

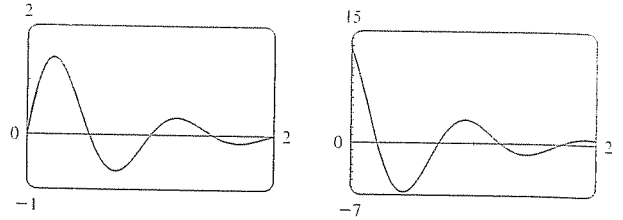
Exercises 3.5 □ page 221

1.  $10(x^2 + 4x + 6)^4(x + 2)$   
 3.  $-\sin(\tan x) \sec^2 x$  5.  $e^{\sqrt{x}}/(2\sqrt{x})$   
 7.  $F'(x) = 7(x^3 + 4x)^6(3x^2 + 4)$  [or  $7x^6(x^2 + 4)^6(3x^2 + 4)$ ]  
 9.  $g'(x) = (2x - 7)/(2\sqrt{x^2 - 7x})$   
 11.  $h'(t) = \frac{3}{2}(t - 1/t)^{1/2}(1 + 1/t^2)$   
 13.  $y' = -3x^2 \sin(a^3 + x^3)$  15.  $y' = -me^{-mx}$   
 17.  $G'(x) = 6(3x - 2)^9(5x^2 - x + 1)^{11}(85x^2 - 51x + 9)$   
 19.  $y' = 8(2x - 5)^3(8x^2 - 5)^{-4}(-4x^2 + 30x - 5)$   
 21.  $y' = e^{-x^2}(1 - 2x^2)$  23.  $F'(y) = 39(y - 6)^2/(y + 7)^4$   
 25.  $f'(z) = -\frac{2}{3}(2z - 1)^{-6/5}$  27.  $y' = -\sin x \sec^2(\cos x)$   
 29.  $y' = 5^{-1/x}(\ln 5)/x^2$  31.  $y' = 3 \sin x \cos x (\sin x - \cos x)$   
 33.  $y' = -12 \cos x \sin x (1 + \cos^2 x)^5$   
 35.  $y' = (3e^{3x} + 2e^{4x})/(1 + e^x)^2$   
 37.  $y' = (\cos x - x \sin x)e^{x \cos x}$   
 39.  $y' = [1 + 1/(2\sqrt{x})]/(2\sqrt{x} + \sqrt{x})$   
 41.  $y' = \cos(\tan \sqrt{\sin x})(\sec^2 \sqrt{\sin x})[1/(2\sqrt{\sin x})](\cos x)$   
 43.  $y = -\frac{3}{16}x + \frac{11}{4}$  45.  $y = -x + \pi$   
 47. (a)  $y = \frac{1}{2}x + 1$



49. (a)  $-1/(x^2\sqrt{1-x^2})$   
 51.  $((\pi/2) + 2n\pi, 3), ((3\pi/2) + 2n\pi, -1), n$  an integer  
 53. 28 55. (a) 30 (b) 36  
 57. (a)  $\frac{3}{4}$  (b) Does not exist (c) -2 59. -17.4  
 61. (a)  $F'(x) = e^x f'(e^x)$  (b)  $G'(x) = e^{f(x)} f'(x)$   
 63.  $v(t) = (5\pi/2) \cos(10\pi t)$  cm/s  
 65. (a)  $\dot{a}B/\dot{d}t = (7\pi/54) \cos(2\pi t/5.4)$  (b) 0.16

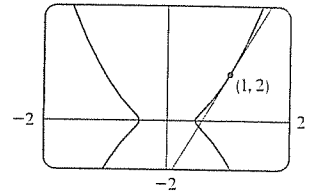
67.  $v(t) = 2e^{-1.5t}(2\pi \cos 2\pi t - 1.5 \sin 2\pi t)$



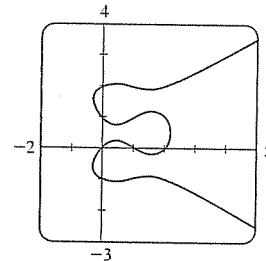
69. (a)  $y \approx 100.012437e^{-10.005531t}$  (b)  $-670.625828 \mu\text{A}$   
 71. (b) The factored form 75. (b)  $-n \cos^{n-1} x \sin[(n +$

Exercises 3.6 □ page 230

1. (a)  $y' = -(y + 2 + 6x)/x$   
 (b)  $y = (4/x) - 2 - 3x, y' = -(4/x^2) - 3$   
 3. (a)  $y' = -y^2/x^2$  (b)  $y = x/(x - 1), y' = -1/(x - 1)^2$   
 5.  $y' = -x/y$  7.  $y' = -x(3x + 2y)/(x^2 + 8y)$   
 9.  $y' = (3 - 2xy - y^2)/(x^2 + 2xy)$   
 11.  $y' = (y/x) + 2(x - y)^2$  [or  $(3x^2 + 1 - 2xy)/(x^2 + 2)$ ]  
 13.  $y' = (4xy\sqrt{xy} - y)/(x - 2x^2\sqrt{xy})$   
 15.  $y' = \tan x \tan y$  17.  $y' = 1 + [e^x(1 + x)]/\sin(x - y)$   
 19.  $y' = -y/x$  21.  $-\frac{1}{6}$   
 23.  $dx/dy = (1 - 4y^3 - 2x^2y - x^4)/(2xy^2 + 4yx^3)$   
 25.  $y = -\frac{5}{4}x - 4$  27.  $y = x$  29.  $y = -\frac{9}{13}x + \frac{40}{13}$   
 31. (a)  $y = \frac{9}{2}x - \frac{5}{2}$  (b)



33. (a) Eight;  $x \approx 0.42, 1.58$   
 (b)  $y = -x + 1,$   
 $y = \frac{1}{3}x + 2$   
 (c)  $1 \mp \sqrt{3}/3$



35.  $(\pm 5\sqrt{3}/4, \pm 5/4)$  37.  $(x_0x/a^2) - (y_0y/b^2) = 1$   
 41.  $y' = 2x/\sqrt{1-x^4}$  43.  $y' = e^x/(1 + e^{2x})$   
 45.  $H'(x) = 1 + 2x \arctan x$  47.  $g'(t) = -4/\sqrt{t^4 - 16t^2}$   
 49.  $y' = 2x \cot^{-1}(3x) - 3x^2/(1 + 9x^2)$   
 51.  $f'(x) = e^x - x^2/(1 + x^2) - 2x \arctan x$   
 57.

