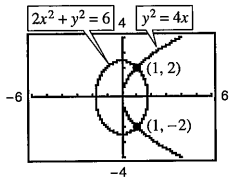
55. $x^2 + y^2 = r^2 \Rightarrow y' = -x/y \Rightarrow y/x =$ slope of normal line. Then for (x_0, y_0) on the circle, $x_0 \neq 0$, an equation of the normal line is $y = (y_0/x_0)x$, which passes through the origin. If $x_0 = 0$, the normal line is vertical and passes through the origin.

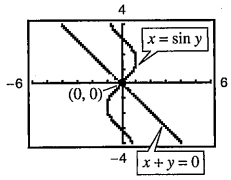
57. Horizontal tangents: $(-4, 0), (-4, 10)$
Vertical tangents: $(0, 5), (-8, 5)$

59.



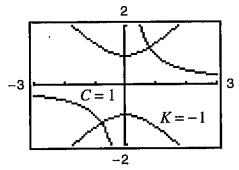
At (1, 2):
Slope of ellipse: -1
Slope of parabola: 1
At (1, −2):
Slope of ellipse: 1
Slope of parabola: -1

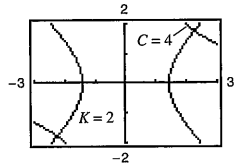
61.



At (0, 0):
Slope of line: -1
Slope of sine curve: 1

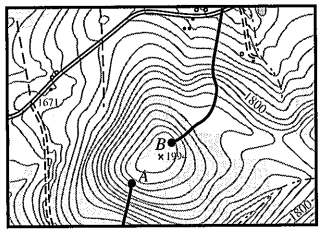
63. Derivatives: $\frac{dy}{dx} = -\frac{y}{x}, \frac{dy}{dx} = \frac{x}{y}$





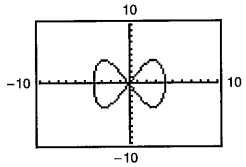
65. Answers will vary. In the explicit form of a function, the variable is explicitly written as a function of x. In an implicit equation, the function is only implied by an equation. An example of an implicit function is $x^2 + xy = 5$. In explicit form, it would be $y = (5 - x^2)/x$.

67.

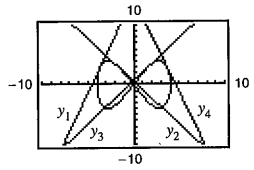


Use starting point B.

69. (a)



(b)

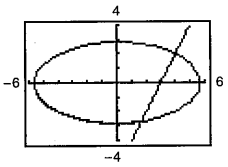


$y_1 = \frac{1}{3}\left[(\sqrt{7} + 7)x + (8\sqrt{7} + 23)\right]$
$y_2 = -\frac{1}{3}\left[(-\sqrt{7} + 7)x - (23 - 8\sqrt{7})\right]$
$y_3 = -\frac{1}{3}\left[(\sqrt{7} - 7)x - (23 - 8\sqrt{7})\right]$
$y_4 = -\frac{1}{3}\left[(\sqrt{7} + 7)x - (8\sqrt{7} + 23)\right]$

(c) $\left(\frac{8\sqrt{7}}{7}, 5\right)$

71. Proof **73.** $y = -\frac{\sqrt{3}}{2}x + 2\sqrt{3}, y = \frac{\sqrt{3}}{2}x - 2\sqrt{3}$

75. (a) $y = 2x - 6$
(b)



(c) $\left(\frac{28}{17}, -\frac{46}{17}\right)$

Section 2.6 *(page 153)*

1. (a) $\frac{3}{4}$ (b) 20 **3.** (a) $-\frac{5}{8}$ (b) $\frac{3}{2}$
5. (a) -8 cm/sec (b) 0 cm/sec (c) 8 cm/sec
7. (a) 12 ft/sec (b) 6 ft/sec (c) 3 ft/sec
9. In a linear function, if x changes at a constant rate, so does y. However, unless $a = 1$, y does not change at the same rate as x.
11. (a) 64π cm^2/min (b) 256π cm^2/min
13. (a) 972π in.^{3}/min; $15{,}552\pi$ in.^{3}/min
(b) If dr/dt is constant, dV/dt is proportional to r^2.
15. (a) 72 cm^3/sec (b) 1800 cm^3/sec
17. $8/(405\pi)$ ft/min **19.** (a) 12.5% (b) $\frac{1}{144}$ m/min
21. (a) $-\frac{7}{12}$ ft/sec; $-\frac{3}{2}$ ft/sec; $-\frac{48}{7}$ ft/sec
(b) $\frac{527}{24}$ ft^2/sec (c) $\frac{1}{12}$ rad/sec
23. Rate of vertical change: $\frac{1}{5}$ m/sec
Rate of horizontal change: $-\sqrt{3}/15$ m/sec
25. (a) -750 mi/h (b) 30 min
27. $-50/\sqrt{85} \approx -5.42$ ft/sec
29. (a) $\frac{25}{3}$ ft/sec (b) $\frac{10}{3}$ ft/sec
31. (a) 12 sec (b) $\frac{1}{2}\sqrt{3}$ m (c) $\sqrt{5}\pi/120$ m/sec
33. Evaporation rate proportional to $S \Rightarrow \frac{dV}{dt} = k(4\pi r^2)$
$V = \left(\frac{4}{3}\right)\pi r^3 \Rightarrow \frac{dV}{dt} = 4\pi r^2 \frac{dr}{dt}$. So $k = \frac{dr}{dt}$.
35. 0.6 ohm/sec **37.** $\frac{dv}{dt} = \frac{16r}{v}\sec^2\theta\frac{d\theta}{dt}, \frac{d\theta}{dt} = \frac{v}{16r}\cos^2\theta\frac{dv}{dt}$
39. $\frac{2\sqrt{21}}{525} \approx 0.017$ rad/sec
41. (a) $\frac{200\pi}{3}$ ft/sec (b) 200π ft/sec
(c) About 427.43π ft/sec
43. About 84.9797 mi/h
45. (a) $\frac{dy}{dt} = 3\frac{dx}{dt}$ means that y changes three times as fast as x changes.
(b) y changes slowly when $x \approx 0$ or $x \approx L$. y changes more rapidly when x is near the middle of the interval.
47. -18.432 ft/sec^2 **49.** About -97.96 m/sec

Review Exercises for Chapter 2 *(page 157)*

1. $f'(x) = 0$ **3.** $f'(x) = 2x - 4$ **5.** 5
7. f is differentiable at all $x \neq 3$. **9.** 0 **11.** $3x^2 - 22x$
13. $\frac{3}{\sqrt{x}} + \frac{1}{\sqrt[3]{x^2}}$ **15.** $-\frac{4}{3t^3}$ **17.** $4 - 5\cos\theta$
19. $-3\sin\theta - (\cos\theta)/4$ **21.** -1 **23.** 0
25. (a) 50 vibrations/sec/lb (b) 33.33 vibrations/sec/lb