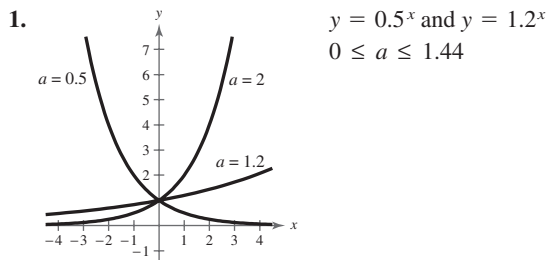


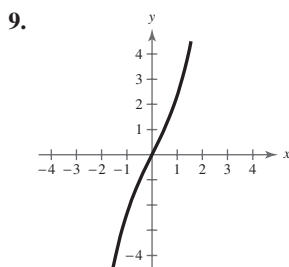
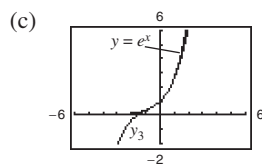
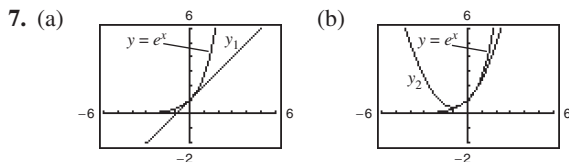
The model is a good fit for the data.
 (d) 65.9 Yes, this is a reasonable answer.

Problem Solving (page 279)



3. As $x \rightarrow \infty$, the graph of e^x increases at a greater rate than the graph of x^n .

5. Answers will vary.

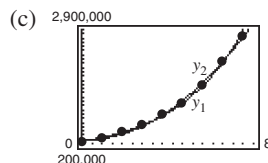


$$f^{-1}(x) = \ln\left(\frac{x + \sqrt{x^2 + 4}}{2}\right)$$

11. c 13. $t = \frac{\ln c_1 - \ln c_2}{\left(\frac{1}{k_2} - \frac{1}{k_1}\right) \ln \frac{1}{2}}$

15. (a) $y_1 = 252,606(1.0310)^t$
 (b) $y_2 = 400.88t^2 - 1464.6t + 291,782$

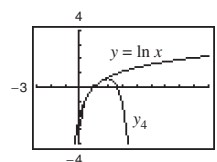
Answers to Odd-Numbered Exercises and Tests



(d) The exponential model is a better fit. No, because the model is rapidly approaching infinity.

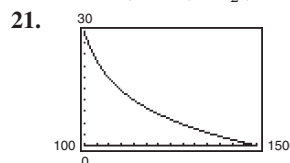
17. $1, e^2$

19. $y_4 = (x - 1) - \frac{1}{2}(x - 1)^2 + \frac{1}{3}(x - 1)^3 - \frac{1}{4}(x - 1)^4$

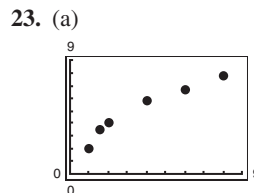


The pattern implies that

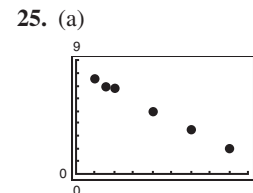
$$\ln x = (x - 1) - \frac{1}{2}(x - 1)^2 + \frac{1}{3}(x - 1)^3 - \dots$$



17.7 cubic feet per minute



(b)–(e)
 Answers will vary.



(b)–(e)
 Answers will vary.

Chapter 4

Section 4.1 (page 290)

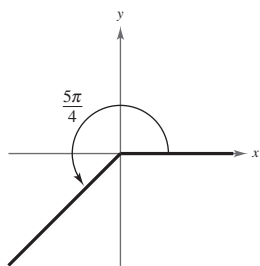
Vocabulary Check (page 290)

- 1. Trigonometry 2. angle 3. coterminal
- 4. radian 5. acute; obtuse
- 6. complementary; supplementary 7. degree
- 8. linear 9. angular 10. $A = \frac{1}{2}r^2\theta$

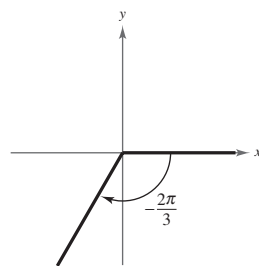
- 1. 2 radians 3. -3 radians 5. 1 radian
- 7. (a) Quadrant I (b) Quadrant III
- 9. (a) Quadrant IV (b) Quadrant III
- 11. (a) Quadrant III (b) Quadrant II

A132 Answers to Odd-Numbered Exercises and Tests

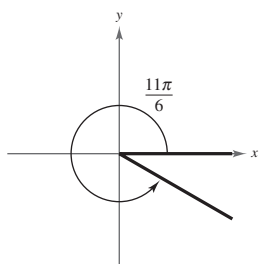
13. (a)



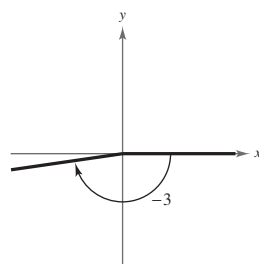
(b)



15. (a)



(b)



17. (a) $\frac{13\pi}{6}, -\frac{11\pi}{6}$ (b) $\frac{17\pi}{6}, -\frac{7\pi}{6}$

19. (a) $\frac{8\pi}{3}, -\frac{4\pi}{3}$ (b) $\frac{25\pi}{12}, -\frac{23\pi}{12}$

21. (a) Complement: $\frac{\pi}{6}$; Supplement: $\frac{2\pi}{3}$

(b) Complement: none; Supplement: $\frac{\pi}{4}$

23. (a) Complement: $\frac{\pi}{2} - 1 \approx 0.57$;

Supplement: $\pi - 1 \approx 2.14$

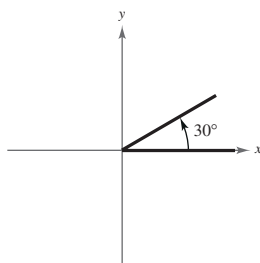
(b) Complement: none; Supplement: $\pi - 2 \approx 1.14$

25. 210° 27. -60° 29. 165°

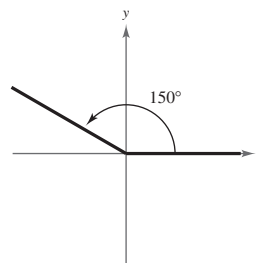
31. (a) Quadrant II (b) Quadrant IV

33. (a) Quadrant III (b) Quadrant I

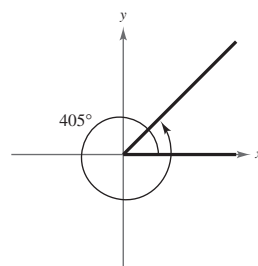
35. (a)



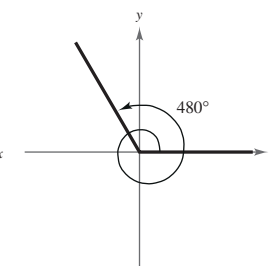
(b)



37. (a)



(b)



39. (a) $405^\circ, -315^\circ$ (b) $324^\circ, -396^\circ$

41. (a) $600^\circ, -120^\circ$ (b) $180^\circ, -540^\circ$

43. (a) Complement: 72° ; Supplement: 162°

(b) Complement: none; Supplement: 65°

45. (a) Complement: 11° ; Supplement: 101°

(b) Complement: none; Supplement: 30°

47. (a) $\frac{\pi}{6}$ (b) $\frac{5\pi}{6}$ 49. (a) $-\frac{\pi}{9}$ (b) $-\frac{4\pi}{3}$

51. (a) 270° (b) 210° 53. (a) 420° (b) -66°

55. 2.007 57. -3.776 59. 9.285 61. -0.014

63. 25.714° 65. 337.500° 67. -756.000°

69. -114.592° 71. (a) 54.75° (b) -128.5°

73. (a) 85.308° (b) 330.007°

75. (a) $240^\circ 36'$ (b) $-145^\circ 48'$

77. (a) $2^\circ 30'$ (b) $-3^\circ 34' 48''$

79. $\frac{6}{5}$ radians 81. $\frac{32}{7}$ radians 83. $\frac{2}{9}$ radian

85. $\frac{50}{29}$ radians 87. 15π inches ≈ 47.12 inches

89. 3 meters 91. $\frac{8\pi}{3}$ square inches ≈ 8.38 square inches

93. 12.27 square feet 95. 591.3 miles

97. 0.071 radian $\approx 4.04^\circ$ 99. $\frac{5}{12}$ radian

101. (a) 728.3 revolutions per minute

(b) 4576 radians per minute

103. (a) $10,400\pi$ radians per minute

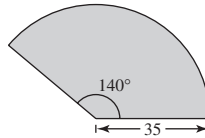
$\approx 32,672.56$ radians per minute

(b) $9425\pi/3$ feet per minute ≈ 9869.84 feet per minute

105. (a) $[400\pi, 1000\pi]$ radians per minute

(b) $[2400\pi, 6000\pi]$ centimeters per minute

107.



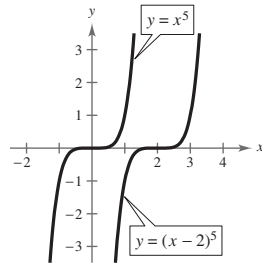
$A = 476.39\pi$ square meters ≈ 1496.62 square meters

109. False. A measurement of 4π radians corresponds to two complete revolutions from the initial to the terminal side of an angle.

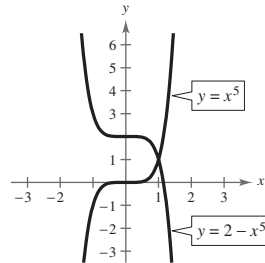
111. False. The terminal side of the angle lies on the x -axis.
 113. Increases. The linear velocity is proportional to the radius.
 115. The arc length is increasing. If θ is constant, the length of the arc is proportional to the radius ($s = r\theta$).

117. $\frac{\sqrt{2}}{2}$ 119. $2\sqrt{10}$

121.



123.



Section 4.2 (page 299)

Vocabulary Check (page 299)

1. unit circle 2. periodic
 3. period 4. odd; even

1. $\sin \theta = \frac{15}{17}$ $\csc \theta = \frac{17}{15}$
 $\cos \theta = -\frac{8}{17}$ $\sec \theta = -\frac{17}{8}$
 $\tan \theta = -\frac{15}{8}$ $\cot \theta = -\frac{8}{15}$
 3. $\sin \theta = -\frac{5}{13}$ $\csc \theta = -\frac{13}{5}$
 $\cos \theta = \frac{12}{13}$ $\sec \theta = \frac{13}{12}$
 $\tan \theta = -\frac{5}{12}$ $\cot \theta = -\frac{12}{5}$
 5. $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ 7. $\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$ 9. $\left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$
 11. $(0, -1)$
 13. $\sin \frac{\pi}{4} = \frac{\sqrt{2}}{2}$ 15. $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$
 $\cos \frac{\pi}{4} = \frac{\sqrt{2}}{2}$ $\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$
 $\tan \frac{\pi}{4} = 1$ $\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$
 17. $\sin\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$ 19. $\sin \frac{11\pi}{6} = -\frac{1}{2}$
 $\cos\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$ $\cos \frac{11\pi}{6} = \frac{\sqrt{3}}{2}$
 $\tan\left(-\frac{7\pi}{4}\right) = 1$ $\tan \frac{11\pi}{6} = -\frac{\sqrt{3}}{3}$
 21. $\sin\left(-\frac{3\pi}{2}\right) = 1$
 $\cos\left(-\frac{3\pi}{2}\right) = 0$
 $\tan\left(-\frac{3\pi}{2}\right)$ is undefined.

Answers to Odd-Numbered Exercises and Tests

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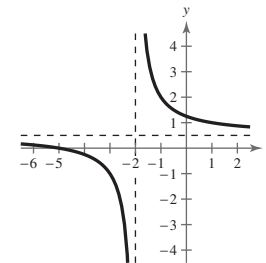
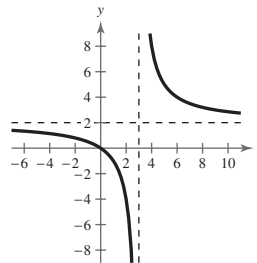
23. $\sin \frac{3\pi}{4} = \frac{\sqrt{2}}{2}$ $\csc \frac{3\pi}{4} = \sqrt{2}$
 $\cos \frac{3\pi}{4} = -\frac{\sqrt{2}}{2}$ $\sec \frac{3\pi}{4} = -\sqrt{2}$
 $\tan \frac{3\pi}{4} = -1$ $\cot \frac{3\pi}{4} = -1$
 25. $\sin\left(-\frac{\pi}{2}\right) = -1$ $\csc\left(-\frac{\pi}{2}\right) = -1$
 $\cos\left(-\frac{\pi}{2}\right) = 0$ $\sec\left(-\frac{\pi}{2}\right)$ is undefined.
 $\tan\left(-\frac{\pi}{2}\right)$ is undefined. $\cot\left(-\frac{\pi}{2}\right) = 0$
 27. $\sin\left(\frac{4\pi}{3}\right) = -\frac{\sqrt{3}}{2}$ $\csc\left(\frac{4\pi}{3}\right) = -\frac{2\sqrt{3}}{3}$
 $\cos\left(\frac{4\pi}{3}\right) = -\frac{1}{2}$ $\sec\left(\frac{4\pi}{3}\right) = -2$
 $\tan\left(\frac{4\pi}{3}\right) = \sqrt{3}$ $\cot\left(\frac{4\pi}{3}\right) = \frac{\sqrt{3}}{3}$
 29. $\sin 5\pi = \sin \pi = 0$ 31. $\cos \frac{8\pi}{3} = \cos \frac{2\pi}{3} = -\frac{1}{2}$

33. $\cos\left(-\frac{15\pi}{2}\right) = \cos \frac{\pi}{2} = 0$
 35. $\sin\left(-\frac{9\pi}{4}\right) = \sin \frac{7\pi}{4} = -\frac{\sqrt{2}}{2}$
 37. (a) $-\frac{1}{3}$ (b) -3 39. (a) $-\frac{1}{5}$ (b) -5
 41. (a) $\frac{4}{5}$ (b) $-\frac{4}{5}$ 43. 0.7071 45. 1.0378
 47. -0.1288 49. 1.3940 51. -1.4486
 53. (a) -1 (b) -0.4
 55. (a) 0.25 or 2.89 (b) 1.82 or 4.46
 57. (a)

t	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	1
y	0.25	0.0138	-0.1501	-0.0249	0.0883

(b) $t \approx 5.5$ (c) The displacement decreases.

59. False. $\sin(-t) = -\sin t$ means that the function is odd, not that the sine of a negative angle is a negative number.
 61. (a) y -axis symmetry (b) $\sin t_1 = \sin(\pi - t_1)$
 (c) $\cos(\pi - t_1) = -\cos t_1$
 63. $f^{-1}(x) = \frac{2}{3}(x + 1)$ 65. $f^{-1}(x) = \sqrt{x^2 + 4}$, $x \geq 0$
 67. 69.



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Section 4.3 (page 308)

Vocabulary Check (page 308)

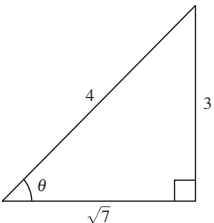
- (a) v (b) iv (c) vi (d) iii (e) i (f) ii
- opposite; adjacent; hypotenuse
- elevation; depression

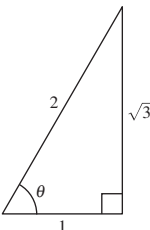
$$\begin{array}{ll}
 1. \sin \theta = \frac{3}{5} & \csc \theta = \frac{5}{3} \\
 \cos \theta = \frac{4}{5} & \sec \theta = \frac{5}{4} \\
 \tan \theta = \frac{3}{4} & \cot \theta = \frac{4}{3} \\
 3. \sin \theta = \frac{9}{41} & \csc \theta = \frac{41}{9} \\
 \cos \theta = \frac{40}{41} & \sec \theta = \frac{41}{40} \\
 \tan \theta = \frac{9}{40} & \cot \theta = \frac{40}{9} \\
 5. \sin \theta = \frac{1}{3} & \csc \theta = 3 \\
 \cos \theta = \frac{2\sqrt{2}}{3} & \sec \theta = \frac{3\sqrt{2}}{4} \\
 \tan \theta = \frac{\sqrt{2}}{4} & \cot \theta = 2\sqrt{2}
 \end{array}$$

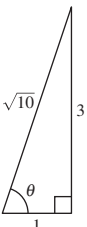
The triangles are similar, and corresponding sides are proportional.

$$\begin{array}{ll}
 7. \sin \theta = \frac{3}{5} & \csc \theta = \frac{5}{3} \\
 \cos \theta = \frac{4}{5} & \sec \theta = \frac{5}{4} \\
 \tan \theta = \frac{3}{4} & \cot \theta = \frac{4}{3}
 \end{array}$$

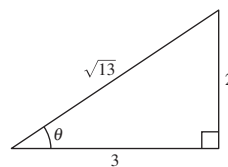
The triangles are similar, and corresponding sides are proportional.

$$\begin{array}{ll}
 9. \cos \theta = \frac{\sqrt{7}}{4} & \sec \theta = \frac{4\sqrt{7}}{7} \\
 \tan \theta = \frac{3\sqrt{7}}{7} & \cot \theta = \frac{\sqrt{7}}{3} \\
 \csc \theta = \frac{4}{3} &
 \end{array}$$


$$\begin{array}{ll}
 11. \sin \theta = \frac{\sqrt{3}}{2} & \csc \theta = \frac{2\sqrt{3}}{3} \\
 \cos \theta = \frac{1}{2} & \cot \theta = \frac{\sqrt{3}}{3} \\
 \tan \theta = \sqrt{3} &
 \end{array}$$


$$\begin{array}{ll}
 13. \sin \theta = \frac{3\sqrt{10}}{10} & \csc \theta = \sqrt{10} \\
 \cos \theta = \frac{\sqrt{10}}{10} & \cot \theta = \frac{1}{3} \\
 \csc \theta = \frac{\sqrt{10}}{3} &
 \end{array}$$


15.



$$\begin{array}{ll}
 \sin \theta = \frac{2\sqrt{13}}{13} & \csc \theta = \frac{\sqrt{13}}{2} \\
 \cos \theta = \frac{3\sqrt{13}}{13} & \sec \theta = \frac{\sqrt{13}}{3} \\
 \tan \theta = \frac{2}{3} &
 \end{array}$$

$$17. \frac{\pi}{6}; \frac{1}{2} \quad 19. 60^\circ; \sqrt{3} \quad 21. 60^\circ; \frac{\pi}{3} \quad 23. 30^\circ; \frac{\sqrt{3}}{2}$$

$$25. 45^\circ; \frac{\pi}{4} \quad 27. (a) \sqrt{3} \quad (b) \frac{1}{2} \quad (c) \frac{\sqrt{3}}{2} \quad (d) \frac{\sqrt{3}}{3}$$

$$29. (a) \frac{2\sqrt{13}}{13} \quad (b) \frac{3\sqrt{13}}{13} \quad (c) \frac{2}{3} \quad (d) \frac{\sqrt{13}}{2}$$

$$31. (a) 3 \quad (b) \frac{2\sqrt{2}}{3} \quad (c) \frac{\sqrt{2}}{4} \quad (d) \frac{1}{3}$$

33–41. Answers will vary. 43. (a) 0.1736 (b) 0.1736

45. (a) 0.2815 (b) 3.5523

47. (a) 1.3499 (b) 1.3432

49. (a) 5.0273 (b) 0.1989

51. (a) 1.8527 (b) 0.9817

$$53. (a) 30^\circ = \frac{\pi}{6} \quad (b) 30^\circ = \frac{\pi}{6}$$

$$55. (a) 60^\circ = \frac{\pi}{3} \quad (b) 45^\circ = \frac{\pi}{4}$$

$$57. (a) 60^\circ = \frac{\pi}{3} \quad (b) 45^\circ = \frac{\pi}{4}$$

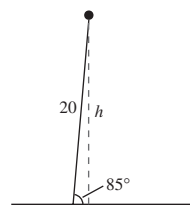
$$59. 30\sqrt{3} \quad 61. \frac{32\sqrt{3}}{3}$$

$$63. 443.2 \text{ meters}; 323.3 \text{ meters} \quad 65. 30^\circ = \frac{\pi}{6}$$

67. (a) 371.1 feet (b) 341.6 feet
(c) Moving down line at 61.8 feet per second
Dropping vertically at 24.2 feet per second

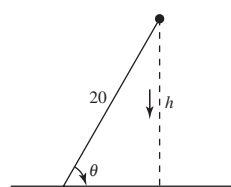
$$69. (x_1, y_1) = (28\sqrt{3}, 28) \\ (x_2, y_2) = (28, 28\sqrt{3})$$

$$71. (a) \quad (b) \sin 85^\circ = \frac{h}{20} \\ (c) 19.9 \text{ meters}$$



(d) The side of the triangle labeled h will become shorter.

Angle, θ	80°	70°	60°	50°
Height	19.7	18.8	17.3	15.3
Angle, θ	40°	30°	20°	10°
Height	12.9	10.0	6.8	3.5

(f) As $\theta \rightarrow 0^\circ$, $h \rightarrow 0$.

73. True, $\csc x = \frac{1}{\sin x}$. 75. False, $\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2} \neq 1$.

77. False, $1.7321 \neq 0.0349$.

79. Corresponding sides of similar triangles are proportional.

81. (a)

θ	0.1	0.2	0.3	0.4	0.5
$\sin \theta$	0.0998	0.1987	0.2955	0.3894	0.4794

(b) θ (c) As θ approaches 0, $\sin \theta$ approaches 0.

83. $\frac{x}{x-2}$, $x \neq \pm 2$ 85. $\frac{2(x^2 - 5x - 10)}{(x-2)(x+2)^2}$

Section 4.4 (page 318)

Vocabulary Check (page 318)

1. $\frac{y}{r}$ 2. $\csc \theta$ 3. $\frac{y}{x}$ 4. $\frac{r}{x}$ 5. $\cos \theta$
6. $\cot \theta$ 7. reference

1. (a) $\sin \theta = \frac{3}{5}$ (b) $\sin \theta = -\frac{15}{17}$
 $\cos \theta = \frac{4}{5}$ $\cos \theta = \frac{8}{17}$
 $\tan \theta = \frac{3}{4}$ $\tan \theta = -\frac{15}{8}$
 $\csc \theta = \frac{5}{3}$ $\csc \theta = -\frac{17}{15}$
 $\sec \theta = \frac{5}{4}$ $\sec \theta = \frac{17}{8}$
 $\cot \theta = \frac{4}{3}$ $\cot \theta = -\frac{8}{15}$
3. (a) $\sin \theta = -\frac{1}{2}$ (b) $\sin \theta = \frac{\sqrt{17}}{17}$
 $\cos \theta = -\frac{\sqrt{3}}{2}$ $\cos \theta = -\frac{4\sqrt{17}}{17}$
 $\tan \theta = \frac{\sqrt{3}}{3}$ $\tan \theta = -\frac{1}{4}$
 $\csc \theta = -2$ $\csc \theta = \sqrt{17}$
 $\sec \theta = -\frac{2\sqrt{3}}{3}$ $\sec \theta = -\frac{\sqrt{17}}{4}$
 $\cot \theta = \sqrt{3}$ $\cot \theta = -4$
5. $\sin \theta = \frac{24}{25}$ $\csc \theta = \frac{25}{24}$
 $\cos \theta = \frac{7}{25}$ $\sec \theta = \frac{25}{7}$
 $\tan \theta = \frac{24}{7}$ $\cot \theta = \frac{7}{24}$

Answers to Odd-Numbered Exercises and Tests

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$$7. \sin \theta = \frac{5\sqrt{29}}{29} \quad \csc \theta = \frac{\sqrt{29}}{5}$$

$$\cos \theta = -\frac{2\sqrt{29}}{29} \quad \sec \theta = -\frac{\sqrt{29}}{2}$$

$$\tan \theta = -\frac{5}{2} \quad \cot \theta = -\frac{2}{5}$$

$$9. \sin \theta = \frac{68\sqrt{5849}}{5849} \quad \csc \theta = \frac{\sqrt{5849}}{68}$$

$$\cos \theta = -\frac{35\sqrt{5849}}{5849} \quad \sec \theta = -\frac{\sqrt{5849}}{35}$$

$$\tan \theta = -\frac{68}{35} \quad \cot \theta = -\frac{35}{68}$$

11. Quadrant III 13. Quadrant II

$$15. \sin \theta = \frac{3}{5} \quad \csc \theta = \frac{5}{3}$$

$$\cos \theta = -\frac{4}{5} \quad \sec \theta = -\frac{5}{4}$$

$$\tan \theta = -\frac{3}{4} \quad \cot \theta = -\frac{4}{3}$$

$$17. \sin \theta = -\frac{15}{17} \quad \csc \theta = -\frac{17}{15}$$

$$\cos \theta = \frac{8}{17} \quad \sec \theta = \frac{17}{8}$$

$$\tan \theta = -\frac{15}{8} \quad \cot \theta = -\frac{8}{15}$$

$$19. \sin \theta = -\frac{\sqrt{10}}{10} \quad \csc \theta = -\sqrt{10}$$

$$\cos \theta = \frac{3\sqrt{10}}{10} \quad \sec \theta = \frac{\sqrt{10}}{3}$$

$$\tan \theta = -\frac{1}{3} \quad \cot \theta = -3$$

$$21. \sin \theta = \frac{\sqrt{3}}{2} \quad \csc \theta = \frac{2\sqrt{3}}{3}$$

$$\cos \theta = -\frac{1}{2} \quad \sec \theta = -2$$

$$\tan \theta = -\sqrt{3} \quad \cot \theta = -\frac{\sqrt{3}}{3}$$

$$23. \sin \theta = 0 \quad \csc \theta \text{ is undefined.}$$

$$\cos \theta = -1 \quad \sec \theta = -1$$

$$\tan \theta = 0 \quad \cot \theta \text{ is undefined.}$$

$$25. \sin \theta = \frac{\sqrt{2}}{2} \quad \csc \theta = \sqrt{2}$$

$$\cos \theta = -\frac{\sqrt{2}}{2} \quad \sec \theta = -\sqrt{2}$$

$$\tan \theta = -1 \quad \cot \theta = -1$$

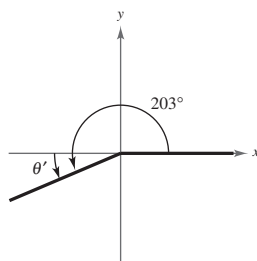
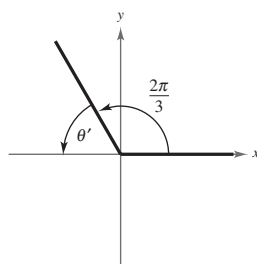
$$27. \sin \theta = -\frac{2\sqrt{5}}{5} \quad \csc \theta = -\frac{\sqrt{5}}{2}$$

$$\cos \theta = -\frac{\sqrt{5}}{5} \quad \sec \theta = -\sqrt{5}$$

$$\tan \theta = 2 \quad \cot \theta = \frac{1}{2}$$

A136 Answers to Odd-Numbered Exercises and Tests

29. 0 **31.** Undefined **33.** 1 **35.** Undefined

37. $\theta' = 23^\circ$

41. $\theta' = \frac{\pi}{3}$


45. $\sin 225^\circ = -\frac{\sqrt{2}}{2}$

$$\cos 225^\circ = -\frac{\sqrt{2}}{2}$$

$$\tan 225^\circ = 1$$

49. $\sin(-150^\circ) = -\frac{1}{2}$

$$\cos(-150^\circ) = -\frac{\sqrt{3}}{2}$$

$$\tan(-150^\circ) = \frac{\sqrt{3}}{3}$$

53. $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$

$$\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$$

$$\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$$

57. $\sin\left(-\frac{3\pi}{2}\right) = 1$

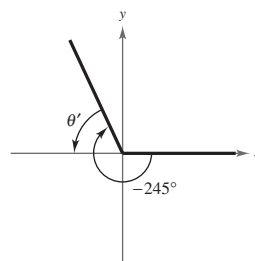
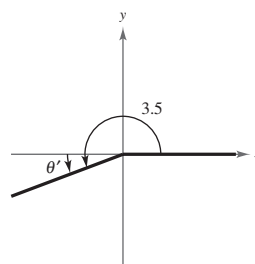
$$\cos\left(-\frac{3\pi}{2}\right) = 0$$

$$\tan\left(-\frac{3\pi}{2}\right) \text{ is undefined.}$$

59. $\frac{4}{5}$ **61.** $-\frac{\sqrt{13}}{2}$ **63.** $\frac{8}{5}$ **65.** 0.1736

67. -0.3420 **69.** -1.4826 **71.** 3.2361

73. 4.6373 **75.** 0.3640 **77.** -0.6052

39. $\theta' = 65^\circ$

43. $\theta' = 3.5 - \pi$


47. $\sin 750^\circ = \frac{1}{2}$

$$\cos 750^\circ = \frac{\sqrt{3}}{2}$$

$$\tan 750^\circ = \frac{\sqrt{3}}{3}$$

51. $\sin \frac{4\pi}{3} = -\frac{\sqrt{3}}{2}$

$$\cos \frac{4\pi}{3} = -\frac{1}{2}$$

$$\tan \frac{4\pi}{3} = \sqrt{3}$$

55. $\sin \frac{11\pi}{4} = \frac{\sqrt{2}}{2}$

$$\cos \frac{11\pi}{4} = -\frac{\sqrt{2}}{2}$$

$$\tan \frac{11\pi}{4} = -1$$

79. -0.4142

81. (a) $30^\circ = \frac{\pi}{6}$, $150^\circ = \frac{5\pi}{6}$ (b) $210^\circ = \frac{7\pi}{6}$, $330^\circ = \frac{11\pi}{6}$

83. (a) $60^\circ = \frac{\pi}{3}$, $120^\circ = \frac{2\pi}{3}$ (b) $135^\circ = \frac{3\pi}{4}$, $315^\circ = \frac{7\pi}{4}$

85. (a) $45^\circ = \frac{\pi}{4}$, $225^\circ = \frac{5\pi}{4}$ (b) $150^\circ = \frac{5\pi}{6}$, $330^\circ = \frac{11\pi}{6}$

87. (a) $N = 22.099 \sin(0.522t - 2.219) + 55.008$

$$F = 36.641 \sin(0.502t - 1.831) + 25.610$$

(b) February: $N = 34.6^\circ$, $F = -1.4^\circ$

March: $N = 41.6^\circ$, $F = 13.9^\circ$

May: $N = 63.4^\circ$, $F = 48.6^\circ$

June: $N = 72.5^\circ$, $F = 59.5^\circ$

August: $N = 75.5^\circ$, $F = 55.6^\circ$

September: $N = 68.6^\circ$, $F = 41.7^\circ$

November: $N = 46.8^\circ$, $F = 6.5^\circ$

(c) Answers will vary.

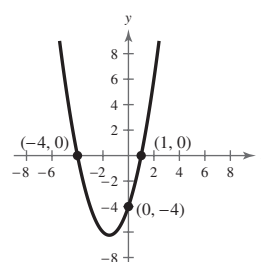
89. (a) 2 centimeters (b) 0.14 centimeter

(c) -1.98 centimeters

91. 0.79 ampere

93. False. In each of the four quadrants, the signs of the secant function and cosine function will be the same, because these functions are reciprocals of each other.

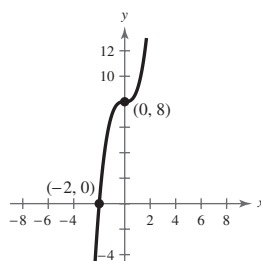
95. As θ increases from 0° to 90° , x decreases from 12 cm to 0 cm and y increases from 0 cm to 12 cm. Therefore, $\sin \theta = y/12$ increases from 0 to 1 and $\cos \theta = x/12$ decreases from 1 to 0. Thus, $\tan \theta = y/x$ and increases without bound. When $\theta = 90^\circ$, the tangent is undefined.

97.


x-intercepts:

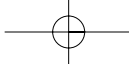
$$(1, 0), (-4, 0)$$

 y-intercept: $(0, -4)$

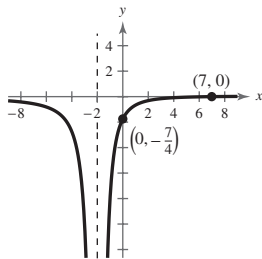
 Domain: all real numbers x
99.

 x-intercept: $(-2, 0)$

 y-intercept: $(0, 8)$

 Domain: all real numbers x

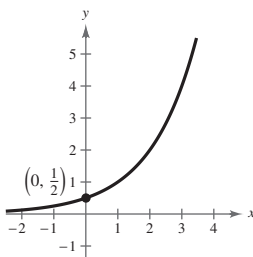


101.



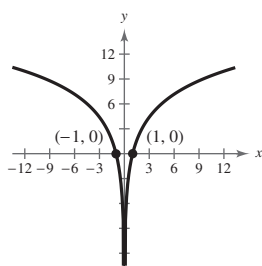
x -intercept: $(7, 0)$
 y -intercept: $(0, -\frac{7}{4})$
 Vertical asymptote:
 $x = -2$
 Horizontal asymptote:
 $y = 0$
 Domain: all real numbers
 x except $x = -2$

103.



y -intercept: $(0, \frac{1}{2})$
 Horizontal asymptote:
 $y = 0$
 Domain: all real numbers x

105.



x -intercepts: $(\pm 1, 0)$
 Vertical asymptote: $x = 0$
 Domain: all real numbers x
 except $x = 0$

Section 4.5 (page 328)

Vocabulary Check (page 328)

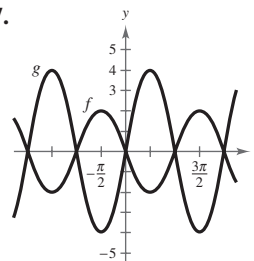
1. cycle 2. amplitude 3. $\frac{2\pi}{b}$
 4. phase shift 5. vertical shift

1. Period: π 3. Period: 4π 5. Period: 6
 Amplitude: 3 Amplitude: $\frac{5}{2}$ Amplitude: $\frac{1}{2}$
 7. Period: 2π 9. Period: $\frac{\pi}{5}$
 Amplitude: 3 Amplitude: 3
 11. Period: 3π 13. Period: 1
 Amplitude: $\frac{1}{2}$ Amplitude: $\frac{1}{4}$
 15. g is a shift of f π units to the right.
 17. g is a reflection of f in the x -axis.
 19. The period of f is twice the period of g .
 21. g is a shift of f three units upward.
 23. The graph of g has twice the amplitude of the graph of f .
 25. The graph of g is a horizontal shift of the graph of f
 π units to the right.

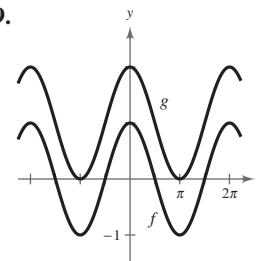
Answers to Odd-Numbered Exercises and Tests

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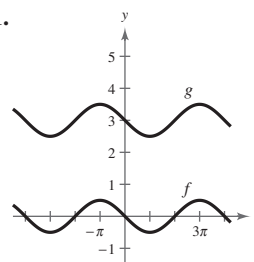
27.



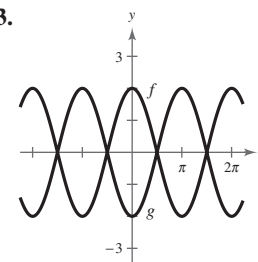
29.



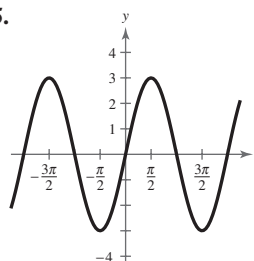
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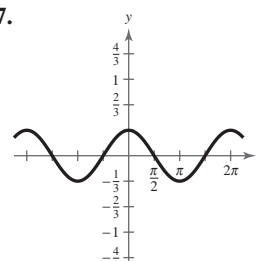
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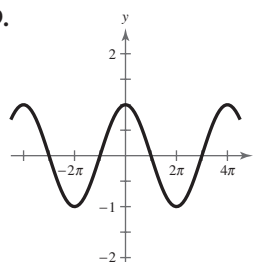
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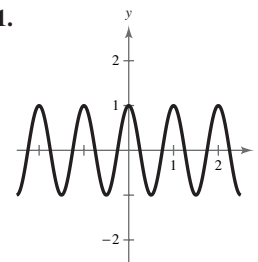
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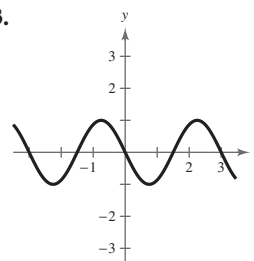
39.



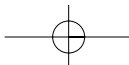
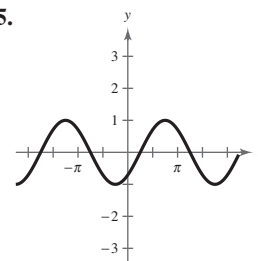
41.



43.

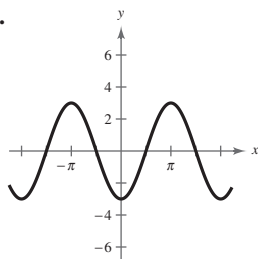


45.

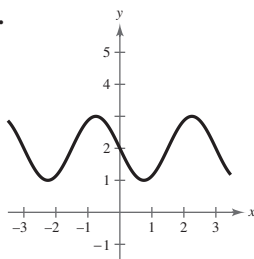


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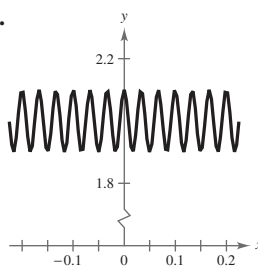
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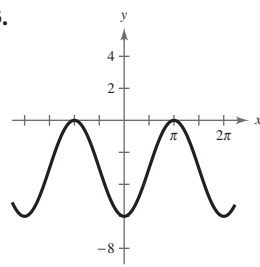
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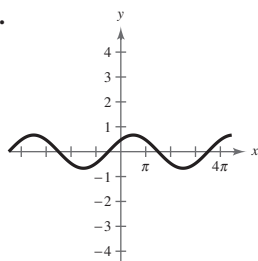
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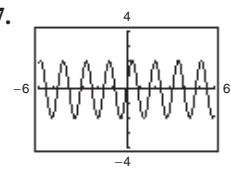
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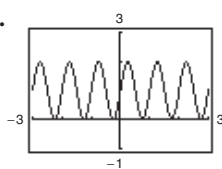
55.



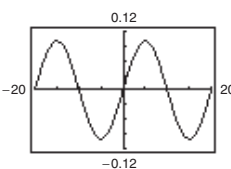
57.



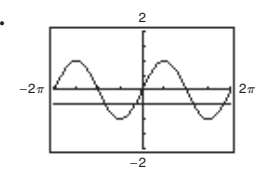
59.



61.

63. $a = 2, d = 1$ 65. $a = -4, d = 4$ 67. $a = -3, b = 2, c = 0$ 69. $a = 2, b = 1, c = -\frac{\pi}{4}$

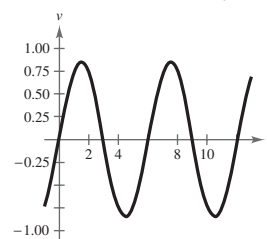
71.



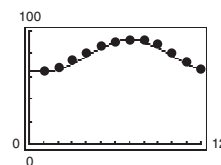
$$x = -\frac{\pi}{6}, -\frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$$

73. (a) 6 seconds (b) 10 cycles per minute

(c)

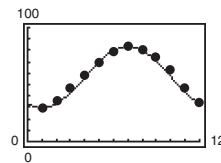
75. (a) $C(t) = 56.55 + 26.95 \cos\left(\frac{\pi}{6}t - 3.67\right)$

(b)



The model is a good fit.

(c)



The model is a good fit.

(d) Tallahassee: 77.90° ; Chicago: 56.55°

The constant term gives the annual average temperature.

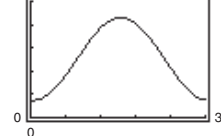
(e) 12; yes; one full period is one year.

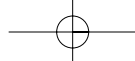
(f) Chicago; amplitude; the greater the amplitude, the greater the variability in temperature.

77. (a) $\frac{1}{440}$ second (b) 440 cycles per second

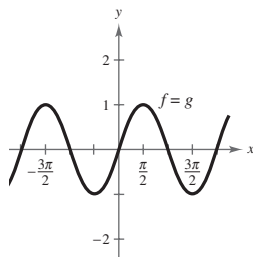
79. (a) 365; answers will vary.

(b) 30.3 gallons; the constant term

(c) $60 < t < 252$ 81. False. The graph of $f(x) = \sin(x + 2\pi)$ translates the graph of $f(x) = \sin x$ exactly one period to the left so that the two graphs look identical.83. True. Because $\cos x = \sin\left(x + \frac{\pi}{2}\right)$, $y = -\cos x$ is a reflection in the x -axis of $y = \sin\left(x + \frac{\pi}{2}\right)$.

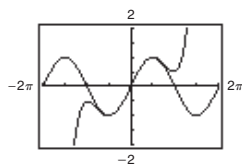


85.



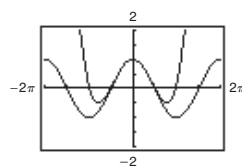
Conjecture: $\sin x = \cos\left(x - \frac{\pi}{2}\right)$

87. (a)



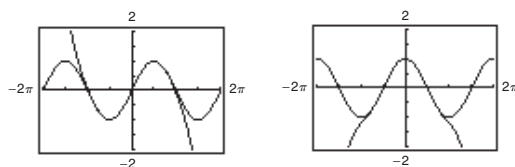
The graphs appear to coincide from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$.

(b)



The graphs appear to coincide from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$.

(c) $\frac{x^7}{7!}, \frac{x^6}{6!}$



The interval of accuracy increased.

89. $\frac{1}{2} \log_{10}(x - 2)$ 91. $3 \ln t - \ln(t - 1)$

93. $\log_{10} \sqrt{xy}$ 95. $\ln \frac{3x}{y^4}$ 97. Answers will vary.

Section 4.6 (page 339)

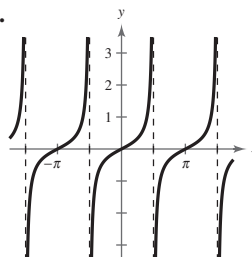
Vocabulary Check (page 339)

- 1. vertical 2. reciprocal 3. damping
- 4. π 5. $x \neq n\pi$ 6. $(-\infty, -1] \cup [1, \infty)$
- 7. 2π

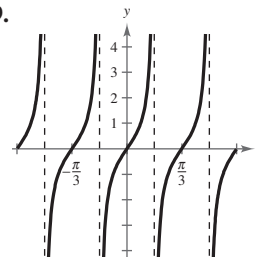
- 1. e, π 2. c, 2π 3. a, 1 4. d, 2π
- 5. f, 4 6. b, 4

Answers to Odd-Numbered Exercises and Tests

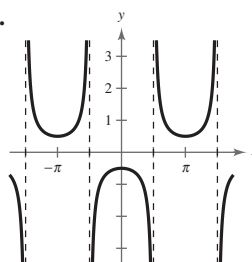
7.



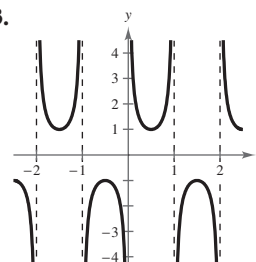
9.



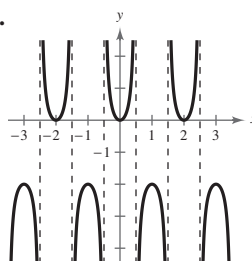
11.



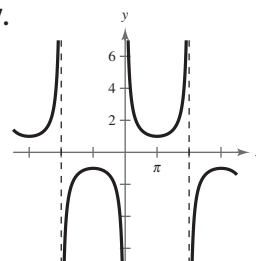
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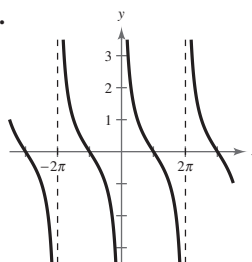
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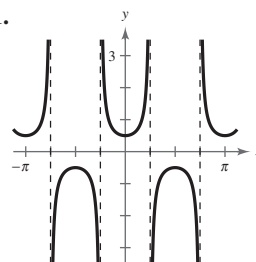
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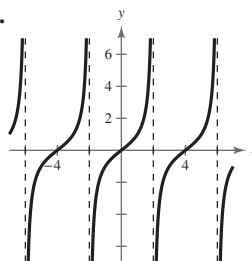
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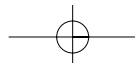
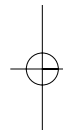
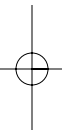
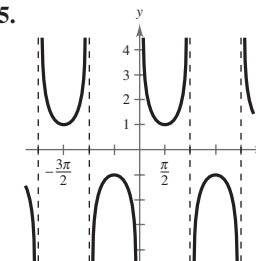
21.



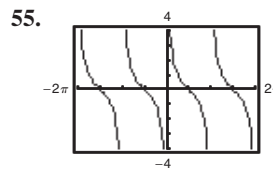
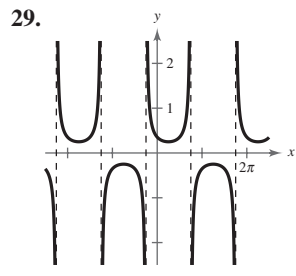
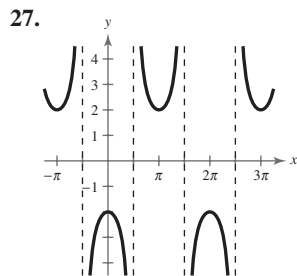
23.



25.



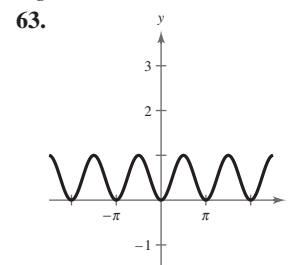
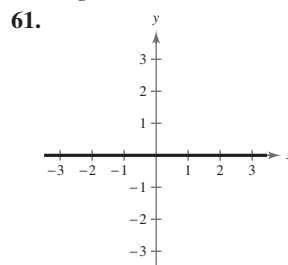
A140 Answers to Odd-Numbered Exercises and Tests



The expressions are equivalent.

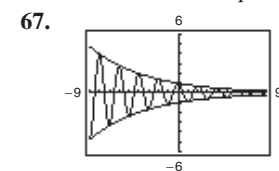
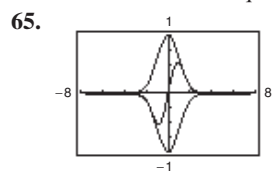
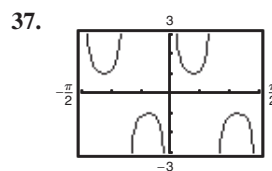
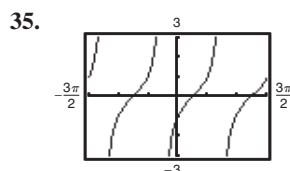
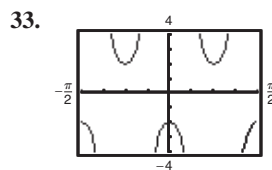
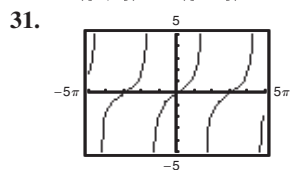
57. $d, f \rightarrow 0$ as $x \rightarrow 0$. 58. $a, f \rightarrow 0$ as $x \rightarrow 0$.

59. $b, g \rightarrow 0$ as $x \rightarrow 0$. 60. $c, g \rightarrow 0$ as $x \rightarrow 0$.



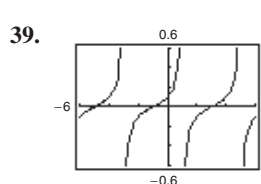
The functions are equal.

The functions are equal.

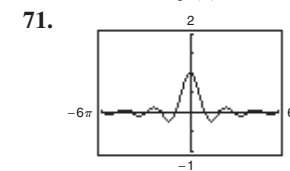
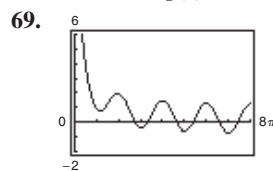


As $x \rightarrow \infty, g(x) \rightarrow 0$.

As $x \rightarrow \infty, f(x) \rightarrow 0$.

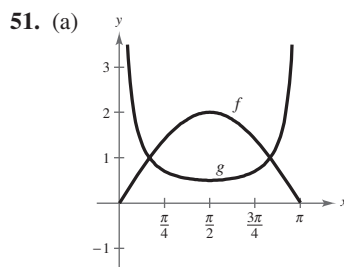


41. $-\frac{7\pi}{4}, -\frac{3\pi}{4}, \frac{\pi}{4}, \frac{5\pi}{4}$

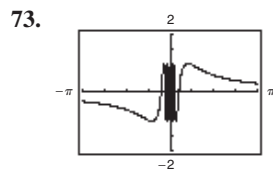


As $x \rightarrow 0, y \rightarrow \infty$.

As $x \rightarrow 0, g(x) \rightarrow 1$.

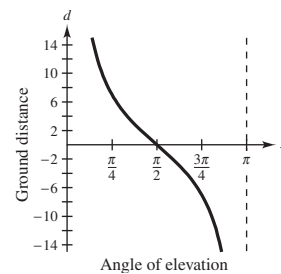


(b) $\frac{\pi}{6} < x < \frac{5\pi}{6}$

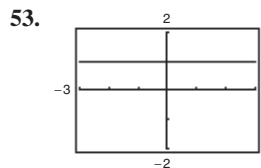


As $x \rightarrow 0, f(x)$ oscillates between 1 and -1.

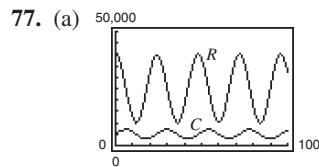
75. $d = 7 \cot x$



(c) f approaches 0 and g approaches $+\infty$ because the cosecant is the reciprocal of the sine.



The expressions are equivalent except that when $\sin x = 0$, y_1 is undefined.



(b) As the predator population increases, the number of prey decreases. When the number of prey is small, the number of predators decreases.

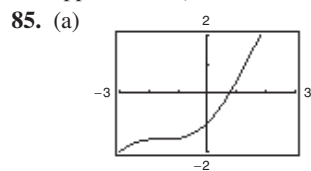
(c) C : 24 months; R : 24 months

79. (a) H : 12 months; L : 12 months

(b) Summer; winter (c) 1 month

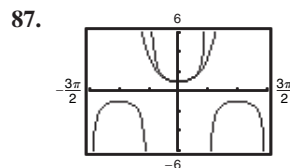
81. True. For a given value of x , the y -coordinate of $\csc x$ is the reciprocal of the y -coordinate of $\sin x$.

83. As x approaches $\pi/2$ from the left, f approaches ∞ . As x approaches $\pi/2$ from the right, f approaches $-\infty$.



0.7391

(b) 1, 0.5403, 0.8576, 0.6543, 0.7935, 0.7014, 0.7640, 0.7221, 0.7504, 0.7314, . . . ; 0.7391



The graphs appear to coincide on the interval $-1.1 \leq x \leq 1.1$.

89. $\frac{\ln 54}{2} \approx 1.994$ 91. $-\ln 2 \approx -0.693$

93. $\frac{2 + e^{73}}{3} \approx 1.684 \times 10^{31}$

95. $\pm\sqrt{e^{3.2} - 1} \approx \pm 4.851$ 97. 2

Section 4.7 (page 349)

Vocabulary Check (page 349)

1. $y = \sin^{-1} x$; $-1 \leq x \leq 1$

2. $y = \arccos x$; $0 \leq y \leq \pi$

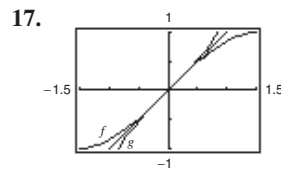
3. $y = \tan^{-1} x$; $-\infty < x < \infty$; $-\frac{\pi}{2} < y < \frac{\pi}{2}$

1. $\frac{\pi}{6}$ 3. $\frac{\pi}{3}$ 5. $\frac{\pi}{6}$ 7. $\frac{5\pi}{6}$ 9. $-\frac{\pi}{3}$

11. $\frac{2\pi}{3}$ 13. $\frac{\pi}{3}$ 15. 0

Answers to Odd-Numbered Exercises and Tests

A141



19. 1.29 21. -0.85 23. -1.25 25. 0.32

27. 1.99 29. 0.74 31. 0.85 33. 1.29

35. $-\frac{\pi}{3}$, $-\frac{\sqrt{3}}{3}$, 1 37. $\theta = \arctan \frac{x}{4}$

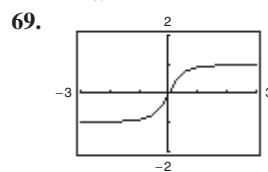
39. $\theta = \arcsin \frac{x+2}{5}$ 41. $\theta = \arccos \frac{x+3}{2x}$

43. 0.3 45. -0.1 47. 0 49. $\frac{3}{5}$ 51. $\frac{\sqrt{5}}{5}$

53. $\frac{12}{13}$ 55. $\frac{\sqrt{34}}{5}$ 57. $\frac{\sqrt{5}}{3}$ 59. $\frac{1}{x}$

61. $\sqrt{1-4x^2}$ 63. $\sqrt{1-x^2}$ 65. $\frac{\sqrt{9-x^2}}{x}$

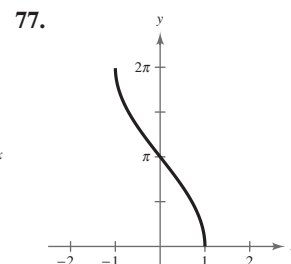
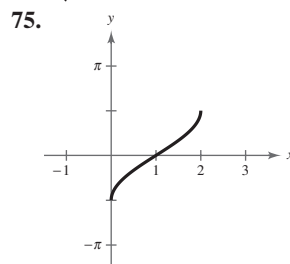
67. $\frac{\sqrt{x^2+2}}{x}$



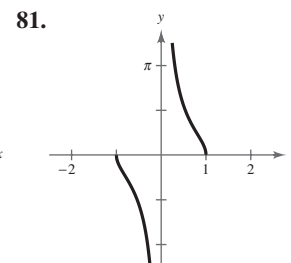
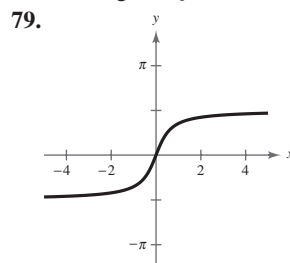
Asymptotes: $y = \pm 1$

71. $\frac{9}{\sqrt{x^2+81}}$, $x > 0$; $\frac{-9}{\sqrt{x^2+81}}$, $x < 0$

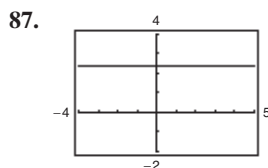
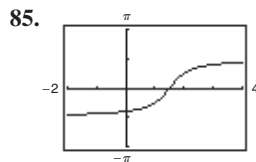
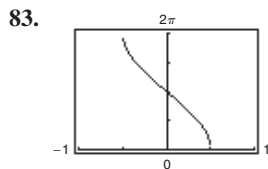
73. $\frac{|x-1|}{\sqrt{x^2-2x+10}}$



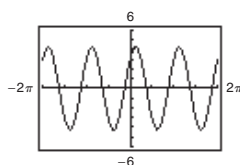
The graph of g is a horizontal shift one unit to the right of f .



A142 Answers to Odd-Numbered Exercises and Tests

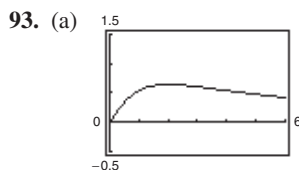


89. $3\sqrt{2} \sin\left(2t + \frac{\pi}{4}\right)$



The graph implies that the identity is true.

91. (a) $\theta = \arcsin \frac{5}{s}$ (b) 0.13, 0.25



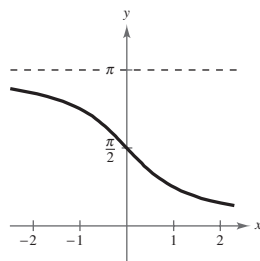
(b) 2 feet (c) $\beta = 0$; As x increases, β approaches 0.

95. (a) $\theta \approx 26.0^\circ$ (b) 24.4 feet

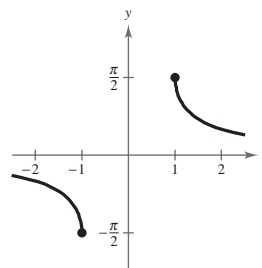
97. (a) $\theta = \arctan \frac{x}{20}$ (b) $14.0^\circ, 31.0^\circ$

99. False. $\frac{5\pi}{4}$ is not in the range of the arctangent.

101. Domain: $(-\infty, \infty)$
Range: $(0, \pi)$

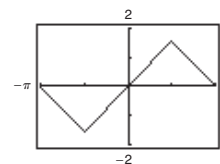
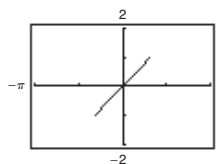


103. Domain: $(-\infty, -1] \cup [1, \infty)$
Range: $[-\pi/2, 0) \cup (0, \pi/2]$



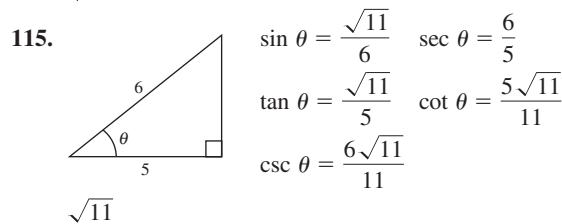
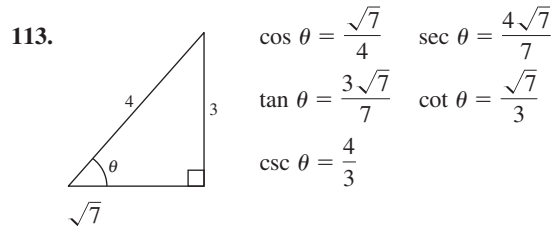
105. (a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$ (c) 1.25 (d) 2.03

107. (a) $f \circ f^{-1}$ (b) $f^{-1} \circ f$



(b) The domains and ranges of the functions are restricted. The graphs of $f \circ f^{-1}$ and $f^{-1} \circ f$ differ because of the domains and ranges of f and f^{-1} .

109. 1279.284 111. 117.391



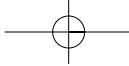
117. Eight people

119. (a) \$21,253.63 (b) \$21,275.17
(c) \$21,285.66 (d) \$21,286.01

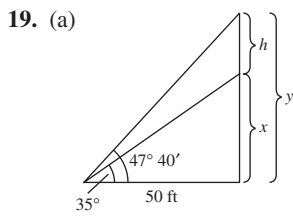
Section 4.8 (page 359)

Vocabulary Check (page 359)

1. elevation; depression
2. bearing
3. harmonic motion



1. $a \approx 3.64$ 3. $a \approx 8.26$ 5. $c \approx 11.66$
 $c \approx 10.64$ $c \approx 25.38$ $A \approx 30.96^\circ$
 $B = 70^\circ$ $A = 19^\circ$ $B \approx 59.04^\circ$
 7. $a \approx 49.48$ 9. $a \approx 91.34$ 11. 2.56 inches
 $A \approx 72.08^\circ$ $b \approx 420.70$
 $B \approx 17.92^\circ$ $B = 77^\circ 45'$
 13. 19.99 inches 15. 107.2 feet 17. 19.7 feet



(b) $h = 50(\tan 47^\circ 40' - \tan 35^\circ)$ (c) 19.9 feet

21. 2236.8 feet

23. (a) (b) $\tan \theta = \frac{12\frac{1}{2}}{17\frac{1}{3}}$ (c) 35.8°

25. 2.06° 27. 0.73 mile
 29. 554 miles north; 709 miles east
 31. (a) 58.18 nautical miles west;
 104.95 nautical miles south
 (b) S 36.7° W; distance = 130.9 nautical miles
 33. (a) N 58° E (b) 68.82 meters
 35. N 56.31° W 37. 1933.3 feet
 39. ≈ 3.23 miles or $\approx 17,054$ feet
 41. 78.7° 43. 35.3° 45. 29.4 inches
 47. $y = \sqrt{3}r$ 49. $a \approx 12.2, b \approx 7$

51. $d = 4 \sin(\pi t)$ 53. $d = 3 \cos\left(\frac{4\pi t}{3}\right)$
 55. (a) 4 (b) 4 (c) 4 (d) $\frac{1}{16}$
 57. (a) $\frac{1}{16}$ (b) 60 (c) 0 (d) $\frac{1}{120}$ 59. $\omega = 528\pi$
 61. (a) (b) $\frac{\pi}{8}$ (c) $\frac{\pi}{32}$

Answers to Odd-Numbered Exercises and Tests **A143**

63. (a)

Base 1	Base 2	Altitude	Area
8	$8 + 16 \cos 30^\circ$	$8 \sin 30^\circ$	59.7
8	$8 + 16 \cos 40^\circ$	$8 \sin 40^\circ$	72.7
8	$8 + 16 \cos 50^\circ$	$8 \sin 50^\circ$	80.5
8	$8 + 16 \cos 60^\circ$	$8 \sin 60^\circ$	83.1
8	$8 + 16 \cos 70^\circ$	$8 \sin 70^\circ$	80.7
8	$8 + 16 \cos 80^\circ$	$8 \sin 80^\circ$	74.0
8	$8 + 16 \cos 90^\circ$	$8 \sin 90^\circ$	64.0

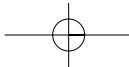
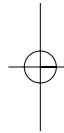
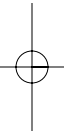
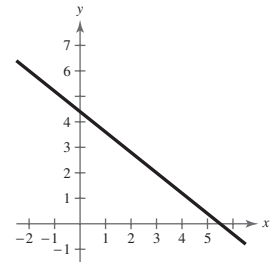
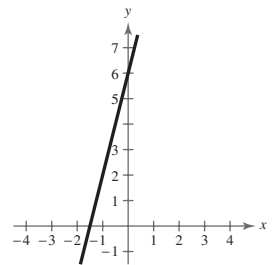
(b)

Base 1	Base 2	Altitude	Area
8	$8 + 16 \cos 56^\circ$	$8 \sin 56^\circ$	82.73
8	$8 + 16 \cos 58^\circ$	$8 \sin 58^\circ$	83.04
8	$8 + 16 \cos 59^\circ$	$8 \sin 59^\circ$	83.11
8	$8 + 16 \cos 60^\circ$	$8 \sin 60^\circ$	83.14
8	$8 + 16 \cos 61^\circ$	$8 \sin 61^\circ$	83.11
8	$8 + 16 \cos 62^\circ$	$8 \sin 62^\circ$	83.04

83.14 square feet
 (c) $A = 64(1 + \cos \theta)(\sin \theta)$
 (d)

≈ 83.1 square feet when $\theta = 60^\circ$
 The answers are the same.

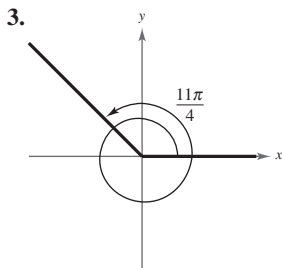
65. False. The tower is leaning, so it is not perfectly vertical and does not form a right angle with the ground.
 67. No. N 24° E means 24 degrees east of north.
 69. $y = 4x + 6$ 71. $y = -\frac{4}{5}x + \frac{22}{5}$



A144 Answers to Odd-Numbered Exercises and Tests

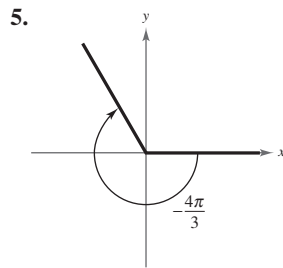
Review Exercises (page 365)

1. 0.5 radian



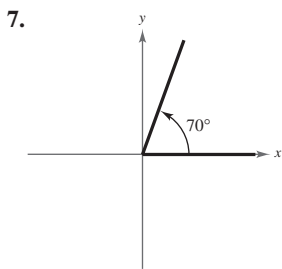
(b) Quadrant II

(c) $\frac{3\pi}{4}, -\frac{5\pi}{4}$



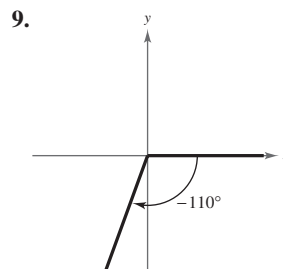
(b) Quadrant II

(c) $\frac{2\pi}{3}, -\frac{10\pi}{3}$



(b) Quadrant I

(c) $430^\circ, -290^\circ$



(b) Quadrant III

(c) $250^\circ, -470^\circ$

11. 8.378 13. -0.589 15. 128.571°

17. -200.535° 19. 478.17 inches

21. (a) $66\frac{2}{3}\pi$ radians per minute

(b) 400π inches per minute

23. Area = 339.28 square inches

25. $(-\frac{1}{2}, \frac{\sqrt{3}}{2})$ 27. $(-\frac{\sqrt{3}}{2}, \frac{1}{2})$

29. $\sin \frac{7\pi}{6} = -\frac{1}{2}$ $\csc \frac{7\pi}{6} = -2$

$\cos \frac{7\pi}{6} = -\frac{\sqrt{3}}{2}$ $\sec \frac{7\pi}{6} = -\frac{2\sqrt{3}}{3}$

$\tan \frac{7\pi}{6} = \frac{\sqrt{3}}{3}$ $\cot \frac{7\pi}{6} = \sqrt{3}$

31. $\sin(-\frac{2\pi}{3}) = -\frac{\sqrt{3}}{2}$ $\csc(-\frac{2\pi}{3}) = -\frac{2\sqrt{3}}{3}$

$\cos(-\frac{2\pi}{3}) = -\frac{1}{2}$ $\sec(-\frac{2\pi}{3}) = -2$

$\tan(-\frac{2\pi}{3}) = \sqrt{3}$ $\cot(-\frac{2\pi}{3}) = \frac{\sqrt{3}}{3}$

33. $\sin \frac{11\pi}{4} = \sin \frac{3\pi}{4} = \frac{\sqrt{2}}{2}$

35. $\sin(-\frac{17\pi}{6}) = \sin \frac{7\pi}{6} = -\frac{1}{2}$

37. -75.3130 39. 3.2361

41. $\sin \theta = \frac{4\sqrt{41}}{41}$

$\cos \theta = \frac{5\sqrt{41}}{41}$

$\tan \theta = \frac{4}{5}$

$\csc \theta = \frac{\sqrt{41}}{4}$

$\sec \theta = \frac{\sqrt{41}}{5}$

$\cot \theta = \frac{5}{4}$

43. $\sin \theta = \frac{\sqrt{3}}{2}$

$\cos \theta = \frac{1}{2}$

$\tan \theta = \sqrt{3}$

$\csc \theta = \frac{2\sqrt{3}}{3}$

$\sec \theta = 2$

$\cot \theta = \frac{\sqrt{3}}{3}$

45. (a) 3 (b) $\frac{2\sqrt{2}}{3}$ (c) $\frac{3\sqrt{2}}{4}$ (d) $\frac{\sqrt{2}}{4}$

47. (a) $\frac{1}{4}$ (b) $\frac{\sqrt{15}}{4}$ (c) $\frac{4\sqrt{15}}{15}$ (d) $\frac{\sqrt{15}}{15}$

49. 0.6494 51. 0.5621 53. 3.6722 55. 71.3 meters

57. $\sin \theta = \frac{4}{5}$ $\csc \theta = \frac{5}{4}$

$\cos \theta = \frac{3}{5}$ $\sec \theta = \frac{5}{3}$

$\tan \theta = \frac{4}{3}$ $\cot \theta = \frac{3}{4}$

59. $\sin \theta = \frac{15\sqrt{241}}{241}$ $\csc \theta = \frac{\sqrt{241}}{15}$

$\cos \theta = \frac{4\sqrt{241}}{241}$ $\sec \theta = \frac{\sqrt{241}}{4}$

$\tan \theta = \frac{15}{4}$ $\cot \theta = \frac{4}{15}$

61. $\sin \theta = \frac{9\sqrt{82}}{82}$ $\csc \theta = \frac{\sqrt{82}}{9}$

$\cos \theta = \frac{-\sqrt{82}}{82}$ $\sec \theta = -\sqrt{82}$

$\tan \theta = -9$ $\cot \theta = -\frac{1}{9}$

63. $\sin \theta = \frac{4\sqrt{17}}{17}$ $\csc \theta = \frac{\sqrt{17}}{4}$

$\cos \theta = \frac{\sqrt{17}}{17}$ $\sec \theta = \sqrt{17}$

$\tan \theta = 4$ $\cot \theta = \frac{1}{4}$

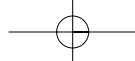
65. $\sin \theta = -\frac{\sqrt{11}}{6}$ 67. $\cos \theta = -\frac{\sqrt{55}}{8}$

$\cos \theta = \frac{5}{6}$ $\tan \theta = -\frac{3\sqrt{55}}{55}$

$\tan \theta = -\frac{\sqrt{11}}{5}$ $\csc \theta = \frac{8}{3}$

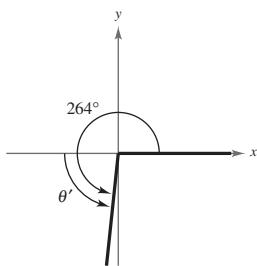
$\csc \theta = -\frac{6\sqrt{11}}{11}$ $\sec \theta = -\frac{8\sqrt{55}}{55}$

$\cot \theta = -\frac{5\sqrt{11}}{11}$ $\cot \theta = -\frac{\sqrt{55}}{3}$

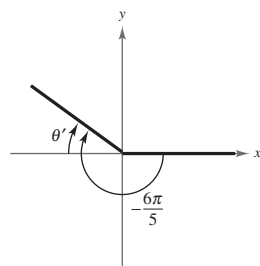


69. $\sin \theta = \frac{\sqrt{21}}{5}$
 $\tan \theta = -\frac{\sqrt{21}}{2}$
 $\csc \theta = \frac{5\sqrt{21}}{21}$
 $\sec \theta = -\frac{5}{2}$
 $\cot \theta = -\frac{2\sqrt{21}}{21}$

71. $\theta' = 84^\circ$



73. $\theta' = \frac{\pi}{5}$



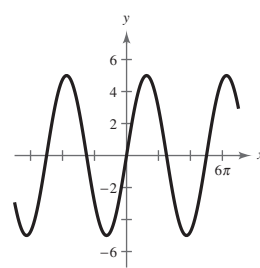
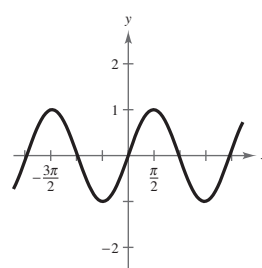
75. $\sin \frac{\pi}{3} = \frac{\sqrt{3}}{2}$; $\cos \frac{\pi}{3} = \frac{1}{2}$; $\tan \frac{\pi}{3} = \sqrt{3}$

77. $\sin\left(-\frac{7\pi}{3}\right) = -\frac{\sqrt{3}}{2}$; $\cos\left(-\frac{7\pi}{3}\right) = \frac{1}{2}$;
 $\tan\left(-\frac{7\pi}{3}\right) = -\sqrt{3}$

79. $\sin 495^\circ = \frac{\sqrt{2}}{2}$; $\cos 495^\circ = -\frac{\sqrt{2}}{2}$; $\tan 495^\circ = -1$

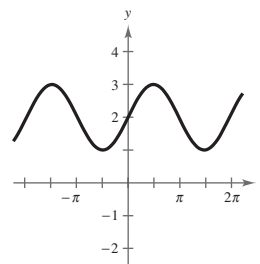
81. $\sin(-240^\circ) = \frac{\sqrt{3}}{2}$; $\cos(-240^\circ) = -\frac{1}{2}$;
 $\tan(-240^\circ) = -\sqrt{3}$

83. -0.7568 85. 0.0584 87. 3.2361

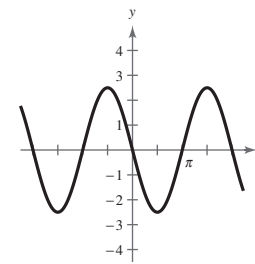


Answers to Odd-Numbered Exercises and Tests

93.



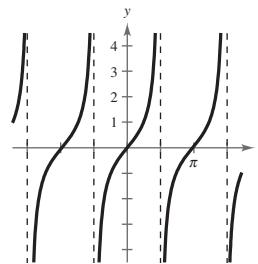
95.



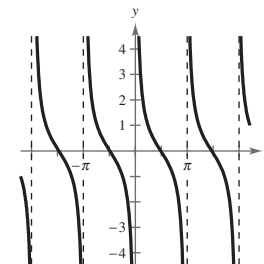
97. (a) $y = 2 \sin 528\pi x$

(b) 264 cycles per second

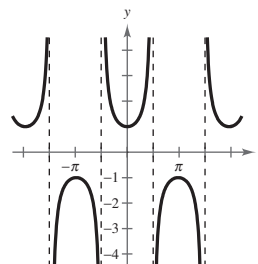
99.



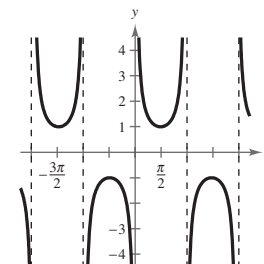
101.



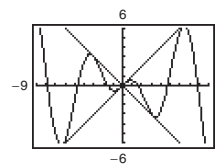
103.



105.



107.

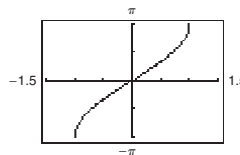


As $x \rightarrow +\infty, f(x) \rightarrow +\infty$

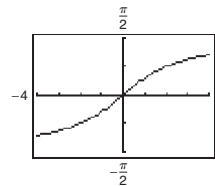
109. $-\frac{\pi}{6}$ 111. 0.41 113. -0.46 115. $\frac{\pi}{6}$

117. π 119. 1.24 121. -0.98

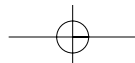
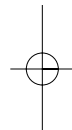
123.



125.

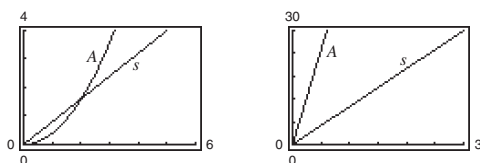


127. $\frac{4}{5}$ 129. $\frac{13}{5}$ 131. $\frac{\sqrt{4-x^2}}{x}$ 133. 66.8°



A146 Answers to Odd-Numbered Exercises and Tests

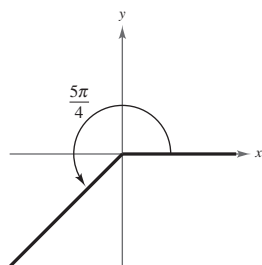
135. 1221 miles, 85.6°
 137. False. The sine or cosine function is often useful for modeling simple harmonic motion.
 139. False. For each θ there corresponds exactly one value of y .
 141. d; The period is 2π and the amplitude is 3.
 143. b; The period is 2 and the amplitude is 2.
 145. The function is undefined because $\sec \theta = 1/\cos \theta$.
 147. The ranges of the other four trigonometric functions are $(-\infty, \infty)$ or $(-\infty, -1] \cup [1, \infty)$.
 149. (a) $A = 0.4r^2, r > 0;$ (b) $A = 50\theta, \theta > 0;$
 $s = 0.8r, r > 0$ $s = 10\theta, \theta > 0$



The area function increases more rapidly.

Chapter Test (page 369)

1. (a)



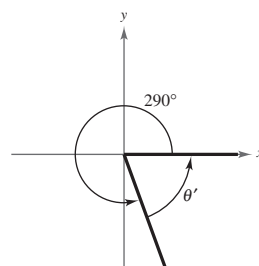
- (b) $\frac{13\pi}{4}, -\frac{3\pi}{4}$
 (c) 225°

2. 3000 radians per minute 3. ≈ 709.04 square feet

4. $\sin \theta = \frac{3\sqrt{10}}{10}$ $\csc \theta = \frac{\sqrt{10}}{3}$
 $\cos \theta = -\frac{\sqrt{10}}{10}$ $\sec \theta = -\sqrt{10}$
 $\tan \theta = -3$ $\cot \theta = -\frac{1}{3}$

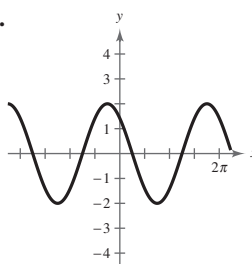
5. For $0 \leq \theta < \frac{\pi}{2}$: For $\pi \leq \theta < \frac{3\pi}{2}$:
 $\sin \theta = \frac{3\sqrt{13}}{13}$ $\sin \theta = -\frac{3\sqrt{13}}{13}$
 $\cos \theta = \frac{2\sqrt{13}}{13}$ $\cos \theta = -\frac{2\sqrt{13}}{13}$
 $\csc \theta = \frac{\sqrt{13}}{3}$ $\csc \theta = -\frac{\sqrt{13}}{3}$
 $\sec \theta = \frac{\sqrt{13}}{2}$ $\sec \theta = -\frac{\sqrt{13}}{2}$
 $\cot \theta = \frac{2}{3}$ $\cot \theta = \frac{2}{3}$

6. $\theta' = 70^\circ$

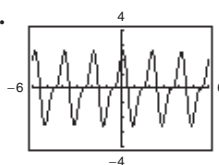


7. Quadrant III 8. $150^\circ, 210^\circ$ 9. 1.33, 1.81
 10. $\sin \theta = -\frac{4}{5}$ 11. $\sin \theta = \frac{15}{17}$
 $\tan \theta = -\frac{4}{3}$ $\cos \theta = -\frac{8}{17}$
 $\csc \theta = -\frac{5}{4}$ $\tan \theta = -\frac{15}{8}$
 $\sec \theta = \frac{5}{3}$ $\csc \theta = \frac{17}{15}$
 $\cot \theta = -\frac{3}{4}$ $\cot \theta = -\frac{8}{15}$

12.

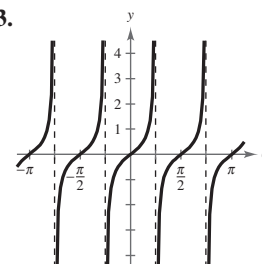


14.

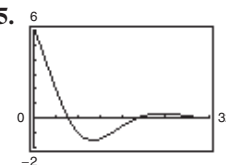


Period: 2

13.



15.

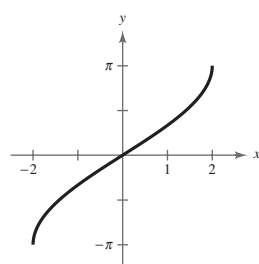


Not periodic

16. $a = -2, b = \frac{1}{2}, c = -\frac{\pi}{4}$

17. $\frac{\sqrt{5}}{2}$

18.



19. 310.1° 20. $d = -6 \cos \pi t$

Problem Solving (page 371)

1. (a) $\frac{11\pi}{2}$ radians or 990° (b) ≈ 816.42 feet