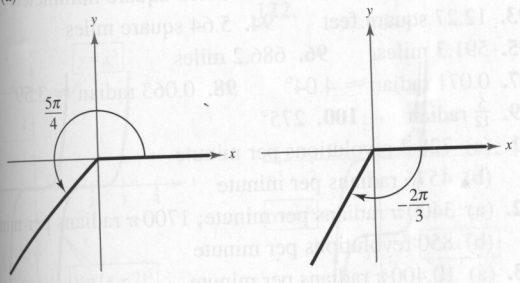
Chapter 4

Section 4.1 *(page 290)*

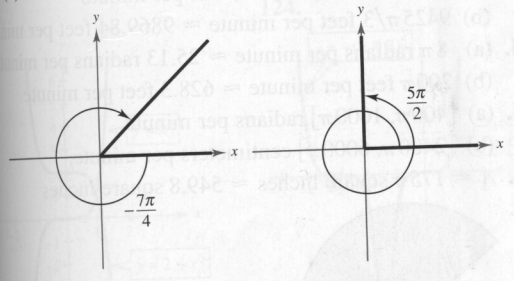
Vocabulary Check *(page 290)*

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

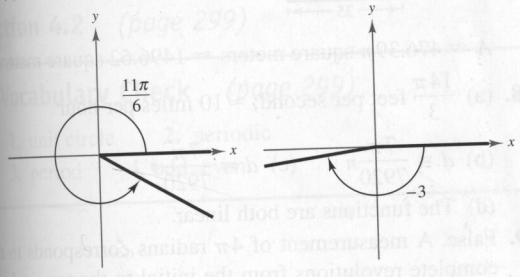
1. 2 radians **2.** 5.5 radians **3.** -3 radians
4. -4 radians **5.** 1 radian **6.** 6.5 radians
7. (a) Quadrant I (b) Quadrant III
8. (a) Quadrant III (b) Quadrant III
9. (a) Quadrant IV (b) Quadrant III
10. (a) Quadrant IV (b) Quadrant II
11. (a) Quadrant III (b) Quadrant II
12. (a) Quadrant IV (b) Quadrant II
13. (a) (b)



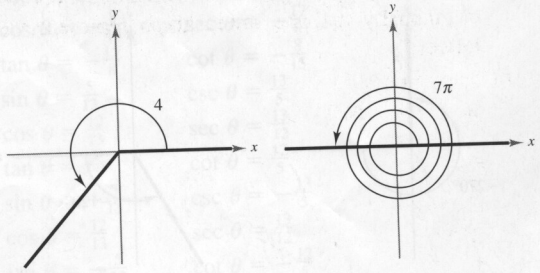
14. (a) (b)



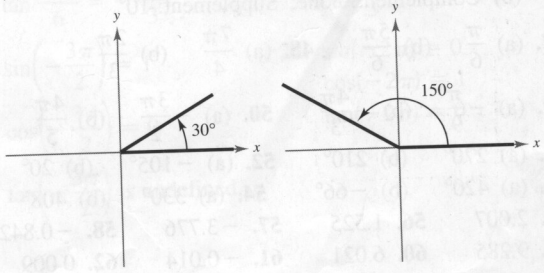
15. (a) (b)



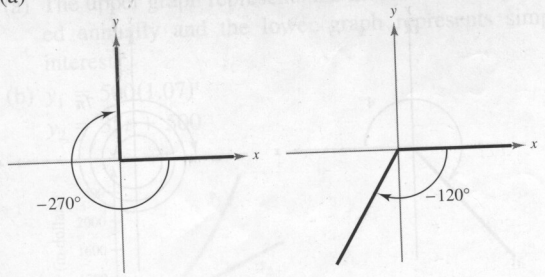
16. (a) (b)



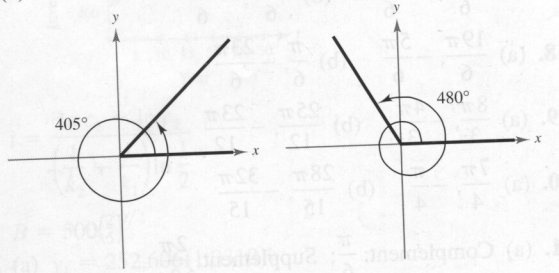
17. (a) $\frac{13\pi}{6}, -\frac{11\pi}{6}$ (b) $\frac{17\pi}{6}, -\frac{7\pi}{6}$
18. (a) $\frac{19\pi}{6}, -\frac{5\pi}{6}$ (b) $\frac{\pi}{6}, -\frac{23\pi}{6}$
19. (a) $\frac{8\pi}{3}, -\frac{4\pi}{3}$ (b) $\frac{25\pi}{12}, -\frac{23\pi}{12}$
20. (a) $\frac{7\pi}{4}, -\frac{\pi}{4}$ (b) $\frac{28\pi}{15}, -\frac{32\pi}{15}$
21. (a) Complement: $\frac{\pi}{6}$; Supplement: $\frac{2\pi}{3}$
    (b) Complement: none; Supplement: $\frac{\pi}{4}$
22. (a) Complement: $\frac{5\pi}{12}$; Supplement: $\frac{11\pi}{12}$
    (b) Complement: none; Supplement: $\frac{\pi}{12}$
23. (a) Complement: $\frac{\pi}{2} - 1 \approx 0.57$;
    Supplement: $\pi - 1 \approx 2.14$
    (b) Complement: none; Supplement: $\pi - 2 \approx 1.14$
24. (a) Complement: none; Supplement: $\pi - 3 \approx 0.14$
    (b) Complement: $\frac{\pi}{2} - 1.5 \approx 0.07$;
    Supplement: $\pi - 1.5 \approx 1.64$
25. 210° **26.** 120° **27.** $-60°$ **28.** $-330°$
29. 165° **30.** 10°
31. (a) Quadrant II (b) Quadrant IV
32. (a) Quadrant I (b) Quadrant III
33. (a) Quadrant III (b) Quadrant I
34. (a) Quadrant II (b) Quadrant IV
35. (a) (b)



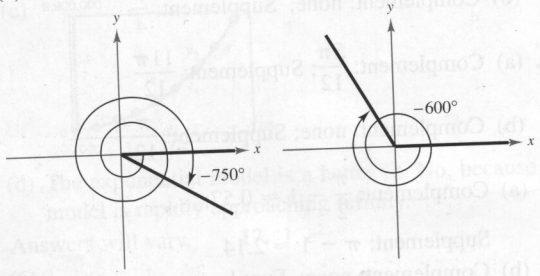
36. (a) (b)



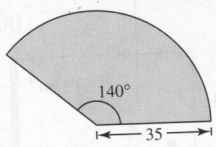
37. (a) (b)



38. (a) (b)



39. (a) 405°, −315° (b) 324°, −396°
40. (a) 480°, −240° (b) 300°, −60°
41. (a) 600°, −120° (b) 180°, −540°
42. (a) 300°, −60° (b) 590°, −130°
43. (a) Complement: 72°; Supplement: 162°
(b) Complement: none; Supplement: 65°
44. (a) Complement: 87°; Supplement: 177°
(b) Complement: 26°; Supplement: 116°
45. (a) Complement: 11°; Supplement: 101°
(b) Complement: none; Supplement: 30°
46. (a) Complement: none; Supplement: 50°
(b) Complement: none; Supplement: 10°
47. (a) $\frac{\pi}{6}$ (b) $\frac{5\pi}{6}$ **48.** (a) $\frac{7\pi}{4}$ (b) $\frac{2\pi}{3}$
49. (a) $-\frac{\pi}{9}$ (b) $-\frac{4\pi}{3}$ **50.** (a) $-\frac{3\pi}{2}$ (b) $\frac{4\pi}{5}$
51. (a) 270° (b) 210° **52.** (a) −105° (b) 20°
53. (a) 420° (b) −66° **54.** (a) 330° (b) 408°
55. 2.007 **56.** 1.525 **57.** −3.776 **58.** −0.842
59. 9.285 **60.** 6.021 **61.** −0.014 **62.** 0.009
63. 25.714° **64.** 81.818° **65.** 337.500°
66. 1170.000° **67.** −756.000° **68.** 864.000°
69. −114.592° **70.** −32.659°
71. (a) 54.75° (b) −128.5°
72. (a) 245.167° (b) 2.2°
73. (a) 85.308° (b) 330.007°
74. (a) −135.01° (b) −408.272°
75. (a) 240° 36′ (b) −145° 48′
76. (a) −345° 7′ 12″ (b) 0° 27′
77. (a) 2° 30′ (b) −3° 34′ 48″
78. (a) −0° 21′ 18″ (b) 0° 47′ 11.4″
79. $\frac{6}{5}$ radians **80.** $\frac{29}{10}$ radians **81.** $\frac{32}{7}$ radians
82. $-\frac{4}{5}$ radian **83.** $\frac{2}{9}$ radian **84.** $\frac{4}{7}$ radian
85. $\frac{50}{29}$ radians **86.** 2 radians
87. 15π inches $\approx$ 47.12 inches **88.** 3π feet $\approx$ 9.42 feet
89. 3 meters **90.** 5π centimeters $\approx$ 15.71 centimeters
91. $\frac{8\pi}{3}$ square inches $\approx$ 8.38 square inches
92. 18π square millimeters $\approx$ 56.55 square millimeters
93. 12.27 square feet **94.** 5.64 square miles
95. 591.3 miles **96.** 686.2 miles
97. 0.071 radian $\approx$ 4.04° **98.** 0.063 radian $\approx$ 3.59°
99. $\frac{5}{12}$ radian **100.** 275°
101. (a) 728.3 revolutions per minute
(b) 4576 radians per minute
102. (a) 3400π radians per minute; 1700π radians per minute
(b) 850 revolutions per minute
103. (a) $10{,}400\pi$ radians per minute
$\approx$ 32,672.56 radians per minute
(b) $9425\pi/3$ feet per minute $\approx$ 9869.84 feet per minute
104. (a) 8π radians per minute $\approx$ 25.13 radians per minute
(b) 200π feet per minute $\approx$ 628.3 feet per minute
105. (a) $[400\pi, 1000\pi]$ radians per minute
(b) $[2400\pi, 6000\pi]$ centimeters per minute
106. $A = 175\pi$ square inches $\approx$ 549.8 square inches
107.



$A = 476.39\pi$ square meters $\approx$ 1496.62 square meters
108. (a) $\frac{14\pi}{3}$ feet per second; $\approx$ 10 miles per hour
(b) $d = \frac{7\pi}{7920}n$ (c) $d = \frac{7\pi}{7920}t$
(d) The functions are both linear.
109. False. A measurement of 4π radians corresponds to two complete revolutions from the initial to the terminal side of an angle.

110. True. Let α and β represent coterminal angles, and let n represent an integer.
$\alpha = \beta + n(360°)$
$\alpha - \beta = n(360°)$

111. False. The terminal side of the angle lies on the x-axis.

112. (a) The vertex is at the origin and the initial side is on the positive x-axis.
(b) Clockwise rotation of the terminal side
(c) Two angles in standard position where the terminal sides coincide
(d) The magnitude of the angle is between 90° and 180°.

113. Increases. The linear velocity is proportional to the radius.

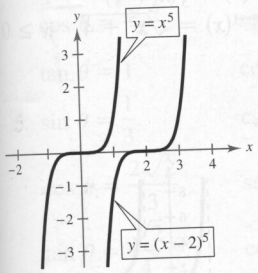
114. Radian. 1 radian $\approx 57.3°$

115. The arc length is increasing. If θ is constant, the length of the arc is proportional to the radius ($s = r\theta$).

116. Answers will vary. **117.** $\frac{\sqrt{2}}{2}$ **118.** $\frac{5\sqrt{2}}{4}$

119. $2\sqrt{10}$ **120.** $4\sqrt{13}$

121.



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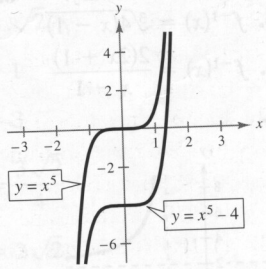
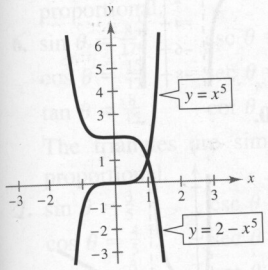
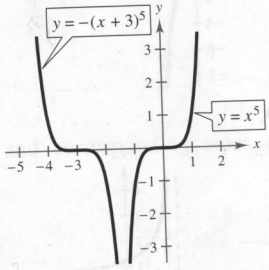


123.



124.



Section 4.2 *(page 299)*

Vocabulary Check *(page 299)*

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

1. $\sin\theta = \frac{15}{17}$ $\csc\theta = \frac{17}{15}$
$\cos\theta = -\frac{8}{17}$ $\sec\theta = -\frac{17}{8}$
$\tan\theta = -\frac{15}{8}$ $\cot\theta = -\frac{8}{15}$

2. $\sin\theta = \frac{5}{13}$ $\csc\theta = \frac{13}{5}$
$\cos\theta = \frac{12}{13}$ $\sec\theta = \frac{13}{12}$
$\tan\theta = \frac{5}{12}$ $\cot\theta = \frac{12}{5}$

3. $\sin\theta = -\frac{5}{13}$ $\csc\theta = -\frac{13}{5}$
$\cos\theta = \frac{12}{13}$ $\sec\theta = \frac{13}{12}$
$\tan\theta = -\frac{5}{12}$ $\cot\theta = -\frac{12}{5}$

4. $\sin\theta = -\frac{3}{5}$ $\csc\theta = -\frac{5}{3}$
$\cos\theta = -\frac{4}{5}$ $\sec\theta = -\frac{5}{4}$
$\tan\theta = \frac{3}{4}$ $\cot\theta = \frac{4}{3}$

5. $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ 6. $\left(\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$ 7. $\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$

8. $\left(-\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right)$ 9. $\left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$ 10. $\left(\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$

11. $(0, -1)$ 12. $(-1, 0)$

13. $\sin\frac{\pi}{4} = \frac{\sqrt{2}}{2}$
$\cos\frac{\pi}{4} = \frac{\sqrt{2}}{2}$
$\tan\frac{\pi}{4} = 1$

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

15. $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$
$\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$
$\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$

16. $\sin\left(-\frac{\pi}{4}\right) = -\frac{\sqrt{2}}{2}$
$\cos\left(-\frac{\pi}{4}\right) = \frac{\sqrt{2}}{2}$
$\tan\left(-\frac{\pi}{4}\right) = -1$

17. $\sin\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$
$\cos\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$
$\tan\left(-\frac{7\pi}{4}\right) = 1$

18. $\sin\left(-\frac{4\pi}{3}\right) = \frac{\sqrt{3}}{2}$
$\cos\left(-\frac{4\pi}{3}\right) = -\frac{1}{2}$
$\tan\left(-\frac{4\pi}{3}\right) = -\sqrt{3}$

19. $\sin\frac{11\pi}{6} = -\frac{1}{2}$
$\cos\frac{11\pi}{6} = \frac{\sqrt{3}}{2}$
$\tan\frac{11\pi}{6} = -\frac{\sqrt{3}}{3}$

20. $\sin\frac{5\pi}{3} = -\frac{\sqrt{3}}{2}$
$\cos\frac{5\pi}{3} = \frac{1}{2}$
$\tan\frac{5\pi}{3} = -\sqrt{3}$

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.

22. $\sin(-2\pi) = 0$
$\cos(-2\pi) = 1$
$\tan(-2\pi) = 0$

23. $\sin\frac{3\pi}{4} = \frac{\sqrt{2}}{2}$ $\quad \csc\frac{3\pi}{4} = \sqrt{2}$

$\cos\frac{3\pi}{4} = -\frac{\sqrt{2}}{2}$ $\quad \sec\frac{3\pi}{4} = -\sqrt{2}$

$\tan\frac{3\pi}{4} = -1$ $\quad \cot\frac{3\pi}{4} = -1$

24. $\sin\frac{5\pi}{6} = \frac{1}{2}$ $\quad \csc\frac{5\pi}{6} = 2$

$\cos\frac{5\pi}{6} = -\frac{\sqrt{3}}{2}$ $\quad \sec\frac{5\pi}{6} = -\frac{2\sqrt{3}}{3}$

$\tan\frac{5\pi}{6} = -\frac{\sqrt{3}}{3}$ $\quad \cot\frac{5\pi}{6} = -\sqrt{3}$

25. $\sin\left(-\frac{\pi}{2}\right) = -1$ $\quad \csc\left(-\frac{\pi}{2}\right) = -1$

$\cos\left(-\frac{\pi}{2}\right) = 0$ $\quad \sec\left(-\frac{\pi}{2}\right)$ is undefined.

$\tan\left(-\frac{\pi}{2}\right)$ is undefined. $\quad \cot\left(-\frac{\pi}{2}\right) = 0$

26. $\sin\frac{3\pi}{2} = -1$ $\quad \csc\frac{3\pi}{2} = -1$

$\cos\frac{3\pi}{2} = 0$ $\quad \sec\frac{3\pi}{2}$ is undefined.

$\tan\frac{3\pi}{2}$ is undefined. $\quad \cot\frac{3\pi}{2} = 0$

27. $\sin\left(\frac{4\pi}{3}\right) = -\frac{\sqrt{3}}{2}$ $\quad \csc\left(\frac{4\pi}{3}\right) = -\frac{2\sqrt{3}}{3}$

$\cos\left(\frac{4\pi}{3}\right) = -\frac{1}{2}$ $\quad \sec\left(\frac{4\pi}{3}\right) = -2$

$\tan\left(\frac{4\pi}{3}\right) = \sqrt{3}$ $\quad \cot\left(\frac{4\pi}{3}\right) = \frac{\sqrt{3}}{3}$

28. $\sin\frac{7\pi}{4} = -\frac{\sqrt{2}}{2}$ $\quad \csc\frac{7\pi}{4} = -\sqrt{2}$

$\cos\frac{7\pi}{4} = \frac{\sqrt{2}}{2}$ $\quad \sec\frac{7\pi}{4} = \sqrt{2}$

$\tan\frac{7\pi}{4} = -1$ $\quad \cot\frac{7\pi}{4} = -1$

29. $\sin 5\pi = \sin\pi = 0$ **30.** $\cos 5\pi = \cos\pi = -1$

31. $\cos\frac{8\pi}{3} = \cos\frac{2\pi}{3} = -\frac{1}{2}$

32. $\sin\frac{9\pi}{4} = \sin\frac{\pi}{4} = \frac{\sqrt{2}}{2}$

33. $\cos\left(-\frac{15\pi}{2}\right) = \cos\frac{\pi}{2} = 0$

34. $\sin\frac{19\pi}{6} = \sin\frac{7\pi}{6} = -\frac{1}{2}$

35. $\sin\left(-\frac{9\pi}{4}\right) = \sin\frac{7\pi}{4} = -\frac{\sqrt{2}}{2}$

36. $\cos\left(-\frac{8\pi}{3}\right) = \cos\frac{4\pi}{3} = -\frac{1}{2}$

37. (a) $-\frac{1}{3}$ (b) -3 **38.** (a) $-\frac{3}{8}$ (b) $-\frac{8}{3}$

39. (a) $-\frac{1}{5}$ (b) -5 **40.** (a) $-\frac{3}{4}$ (b) $-\frac{4}{3}$

41. (a) $\frac{4}{5}$ (b) $-\frac{4}{5}$ **42.** (a) $-\frac{4}{5}$ (b) $-\frac{4}{5}$

43. 0.7071 **44.** 1.7321 **45.** 1.0378 **46.** 0.6421

47. -0.1288 **48.** -0.8011 **49.** 1.3940

50. -4.4014 **51.** -1.4486 **52.** -0.7833

53. (a) -1 (b) -0.4 **54.** (a) 0.7 (b) -0.8

55. (a) 0.25 or 2.89 (b) 1.82 or 4.46

56. (a) 4.0 or 5.4 (b) 0.72 or 5.56

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.

58. (a) 0.25 foot (b) 0.02 foot (c) -0.25 foot

59. False. $\sin(-t) = -\sin t$ means that the function is odd, not that the sine of a negative angle is a negative number.

60. True. The tangent function has a period of π.

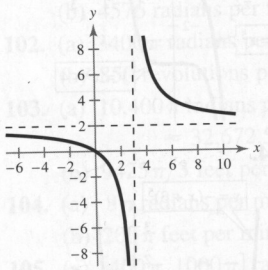
61. (a) y-axis symmetry (b) $\sin t_1 = \sin(\pi - t_1)$
(c) $\cos(\pi - t_1) = -\cos t_1$

62. Answers will vary. **63.** $f^{-1}(x) = \frac{2}{3}(x + 1)$

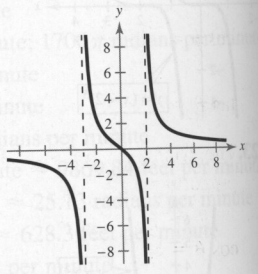
64. $f^{-1}(x) = \sqrt[3]{4(x - 1)}$ **65.** $f^{-1}(x) = \sqrt{x^2 + 4}, \quad x \geq 0$

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

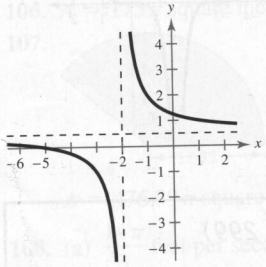
67.



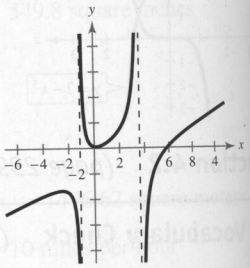
68.



69.



70.



Section 4.3 *(page 308)*

Vocabulary Check *(page 308)*

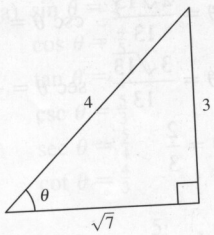
1. (a) v (b) iv (c) vi (d) iii (e) i (f) ii
2. opposite; adjacent; hypotenuse
3. elevation; depression

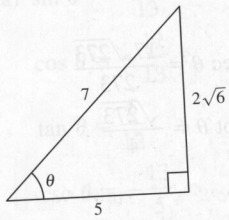
1. $\sin\theta = \frac{3}{5}$ $\csc\theta = \frac{5}{3}$
   $\cos\theta = \frac{4}{5}$ $\sec\theta = \frac{5}{4}$
   $\tan\theta = \frac{3}{4}$ $\cot\theta = \frac{4}{3}$
2. $\sin\theta = \frac{5}{13}$ $\csc\theta = \frac{13}{5}$
   $\cos\theta = \frac{12}{13}$ $\sec\theta = \frac{13}{12}$
   $\tan\theta = \frac{5}{12}$ $\cot\theta = \frac{12}{5}$
3. $\sin\theta = \frac{9}{41}$ $\csc\theta = \frac{41}{9}$
   $\cos\theta = \frac{40}{41}$ $\sec\theta = \frac{41}{40}$
   $\tan\theta = \frac{9}{40}$ $\cot\theta = \frac{40}{9}$
4. $\sin\theta = \frac{\sqrt{2}}{2}$ $\csc\theta = \sqrt{2}$
   $\cos\theta = \frac{\sqrt{2}}{2}$ $\sec\theta = \sqrt{2}$
   $\tan\theta = 1$ $\cot\theta = 1$
5. $\sin\theta = \frac{1}{3}$ $\csc\theta = 3$
   $\cos\theta = \frac{2\sqrt{2}}{3}$ $\sec\theta = \frac{3\sqrt{2}}{4}$
   $\tan\theta = \frac{\sqrt{2}}{4}$ $\cot\theta = 2\sqrt{2}$

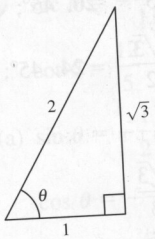
   The triangles are similar, and corresponding sides are proportional.
6. $\sin\theta = \frac{8}{17}$ $\csc\theta = \frac{17}{8}$
   $\cos\theta = \frac{15}{17}$ $\sec\theta = \frac{17}{15}$
   $\tan\theta = \frac{8}{15}$ $\cot\theta = \frac{15}{8}$

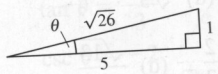
   The triangles are similar, and corresponding sides are proportional.
7. $\sin\theta = \frac{3}{5}$ $\csc\theta = \frac{5}{3}$
   $\cos\theta = \frac{4}{5}$ $\sec\theta = \frac{5}{4}$
   $\tan\theta = \frac{3}{4}$ $\cot\theta = \frac{4}{3}$

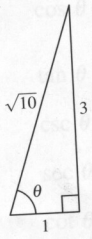
   The triangles are similar, and corresponding sides are proportional.
8. $\sin\theta = \frac{\sqrt{5}}{5}$ $\csc\theta = \sqrt{5}$
   $\cos\theta = \frac{2\sqrt{5}}{5}$ $\sec\theta = \frac{\sqrt{5}}{2}$
   $\tan\theta = \frac{1}{2}$ $\cot\theta = 2$

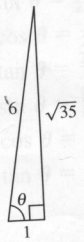
   The triangles are similar, and corresponding sides are proportional.
9. 

   $\cos\theta = \frac{\sqrt{7}}{4}$ $\sec\theta = \frac{4\sqrt{7}}{7}$
   $\tan\theta = \frac{3\sqrt{7}}{7}$ $\cot\theta = \frac{\sqrt{7}}{3}$
   $\csc\theta = \frac{4}{3}$
10. 

   $\sin\theta = \frac{2\sqrt{6}}{7}$ $\sec\theta = \frac{7}{5}$
   $\tan\theta = \frac{2\sqrt{6}}{5}$ $\cot\theta = \frac{5\sqrt{6}}{12}$
   $\csc\theta = \frac{7\sqrt{6}}{12}$
11. 

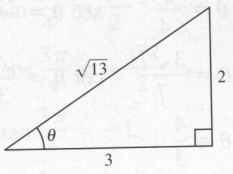
   $\sin\theta = \frac{\sqrt{3}}{2}$ $\csc\theta = \frac{2\sqrt{3}}{3}$
   $\cos\theta = \frac{1}{2}$ $\cot\theta = \frac{\sqrt{3}}{3}$
   $\tan\theta = \sqrt{3}$
12. 

   $\sin\theta = \frac{\sqrt{26}}{26}$ $\csc\theta = \sqrt{26}$
   $\cos\theta = \frac{5\sqrt{26}}{26}$ $\sec\theta = \frac{\sqrt{26}}{5}$
   $\tan\theta = \frac{1}{5}$
13. 

   $\sin\theta = \frac{3\sqrt{10}}{10}$ $\sec\theta = \sqrt{10}$
   $\cos\theta = \frac{\sqrt{10}}{10}$ $\cot\theta = \frac{1}{3}$
   $\csc\theta = \frac{\sqrt{10}}{3}$
14. 

   $\sin\theta = \frac{\sqrt{35}}{6}$ $\csc\theta = \frac{6\sqrt{35}}{35}$
   $\cos\theta = \frac{1}{6}$ $\cot\theta = \frac{\sqrt{35}}{35}$
   $\tan\theta = \sqrt{35}$

15.

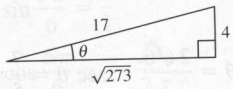


$\sin\theta = \frac{2\sqrt{13}}{13}$ $\csc\theta = \frac{\sqrt{13}}{2}$

$\cos\theta = \frac{3\sqrt{13}}{13}$ $\sec\theta = \frac{\sqrt{13}}{3}$

$\tan\theta = \frac{2}{3}$

16.



$\sin\theta = \frac{4}{17}$ $\sec\theta = \frac{17\sqrt{273}}{273}$

$\cos\theta = \frac{\sqrt{273}}{17}$ $\cot\theta = \frac{\sqrt{273}}{4}$

$\tan\theta = \frac{4\sqrt{273}}{273}$

17. $\frac{\pi}{6}; \frac{1}{2}$ **18.** $\frac{\pi}{4}; \frac{\sqrt{2}}{2}$ **19.** $60°; \sqrt{3}$ **20.** $45°; \sqrt{2}$

21. $60°; \frac{\pi}{3}$ **22.** $45°; \frac{\pi}{4}$ **23.** $30°; \frac{\sqrt{3}}{2}$ **24.** $45°; \frac{\sqrt{2}}{2}$

25. $45°; \frac{\pi}{4}$ **26.** $30°; \frac{\pi}{6}$

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

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

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

30. (a) $\frac{1}{5}$ (b) $\frac{\sqrt{6}}{12}$ (c) $2\sqrt{6}$ (d) $\frac{2\sqrt{6}}{5}$

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

32. (a) $\frac{1}{5}$ (b) $\frac{\sqrt{26}}{26}$ (c) $\frac{1}{5}$ (d) $\frac{\sqrt{26}}{5}$

33–42. Answers will vary.

43. (a) 0.1736 (b) 0.1736

44. (a) 0.4348 (b) 0.4348

45. (a) 0.2815 (b) 3.5523

46. (a) 0.9598 (b) 0.9609

47. (a) 1.3499 (b) 1.3432

48. (a) 0.9964 (b) 1.0036

49. (a) 5.0273 (b) 0.1989

50. (a) 1.7946 (b) 0.5572

51. (a) 1.8527 (b) 0.9817

52. (a) 2.6695 (b) 0.0699

53. (a) $30° = \frac{\pi}{6}$ (b) $30° = \frac{\pi}{6}$

54. (a) $45° = \frac{\pi}{4}$ (b) $45° = \frac{\pi}{4}$

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

56. (a) $60° = \frac{\pi}{3}$ (b) $60° = \frac{\pi}{3}$

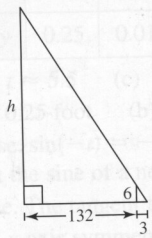
57. (a) $60° = \frac{\pi}{3}$ (b) $45° = \frac{\pi}{4}$

58. (a) $60° = \frac{\pi}{3}$ (b) $45° = \frac{\pi}{4}$

59. $30\sqrt{3}$ **60.** $9\sqrt{3}$ **61.** $\frac{32\sqrt{3}}{3}$

62. $20\sqrt{2}$ **63.** 443.2 meters; 323.3 meters

64. (a)



Not drawn to scale

(b) $\tan\theta = \frac{6}{3} = \frac{h}{135}$

(c) 270 feet

65. $30° = \frac{\pi}{6}$ **66.** 137.6 feet

67. (a) 371.1 feet (b) 341.6 feet

(c) Moving down line at 61.8 feet per second

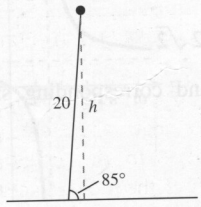
Dropping vertically at 24.2 feet per second

68. 1.3 miles **69.** $(x_1, y_1) = (28\sqrt{3}, 28)$

$(x_2, y_2) = (28, 28\sqrt{3})$

70. 6.57 centimeters

71. (a)



(b) $\sin 85° = \frac{h}{20}$ (c) 19.9 meters

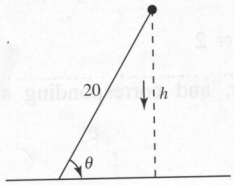
(d) The side of the triangle labeled h will become shorter.

(e)

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 $\theta \to 0°$, $h \to 0$.



72. $\sin 20° \approx 0.34$
$\cos 20° \approx 0.94$
$\tan 20° \approx 0.36$
$\csc 20° \approx 2.92$
$\sec 20° \approx 1.06$
$\cot 20° \approx 2.75$

73. True, $\csc x = \dfrac{1}{\sin x}$. **74.** True, $\sec x = \csc(90° - x)$.

75. False, $\dfrac{\sqrt{2}}{2} + \dfrac{\sqrt{2}}{2} \neq 1$.

76. True, $\cot^2 \theta - \csc^2 \theta = -1$ for all θ.

77. False, $1.7321 \neq 0.0349$.

78. False, $\tan 25° \neq (\tan 5°)(\tan 5°)$.

79. Corresponding sides of similar triangles are proportional.

80. Yes, $\tan \theta$ is equal to opp/adj. You can find the value of the hypotenuse by the Pythagorean Theorem, then you can find $\sec \theta$, which is equal to hyp/adj.

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.

82. (a)

θ	0°	18°	36°	54°	72°	90°
$\sin \theta$	0	0.3090	0.5878	0.8090	0.9511	1
$\cos \theta$	1	0.9511	0.8090	0.5878	0.3090	0

(b) Increasing function (c) Decreasing function

(d) As the angle increases, the length of the side opposite the angle increases relative to the length of the hypotenuse and the length of the side adjacent to the angle decreases relative to the length of the hypotenuse. Thus, the sine increases and the cosine decreases.

83. $\dfrac{x}{x-2}$, $x \neq \pm 6$ **84.** $\dfrac{2t+3}{4-t}$, $t \neq \pm\dfrac{3}{2}$, -4

85. $\dfrac{2(x^2 - 5x - 10)}{(x-2)(x+2)^2}$ **86.** $\dfrac{1}{4}$, $x \neq 0, 12$

Section 4.4 *(page 318)*

Vocabulary Check *(page 318)*

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

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

2. (a) $\sin \theta = -\dfrac{5}{13}$, $\cos \theta = -\dfrac{12}{13}$, $\tan \theta = \dfrac{5}{12}$, $\csc \theta = -\dfrac{13}{5}$, $\sec \theta = -\dfrac{13}{12}$, $\cot \theta = \dfrac{12}{5}$
(b) $\sin \theta = \dfrac{\sqrt{2}}{2}$, $\cos \theta = -\dfrac{\sqrt{2}}{2}$, $\tan \theta = -1$, $\csc \theta = \sqrt{2}$, $\sec \theta = -\sqrt{2}$, $\cot \theta = -1$

3. (a) $\sin \theta = -\dfrac{1}{2}$, $\cos \theta = -\dfrac{\sqrt{3}}{2}$, $\tan \theta = \dfrac{\sqrt{3}}{3}$, $\csc \theta = -2$, $\sec \theta = -\dfrac{2\sqrt{3}}{3}$, $\cot \theta = \sqrt{3}$
(b) $\sin \theta = \dfrac{\sqrt{17}}{17}$, $\cos \theta = -\dfrac{4\sqrt{17}}{17}$, $\tan \theta = -\dfrac{1}{4}$, $\csc \theta = \sqrt{17}$, $\sec \theta = -\dfrac{\sqrt{17}}{4}$, $\cot \theta = -4$

4. (a) $\sin \theta = \dfrac{\sqrt{10}}{10}$, $\cos \theta = \dfrac{3\sqrt{10}}{10}$, $\tan \theta = \dfrac{1}{3}$, $\csc \theta = \sqrt{10}$, $\sec \theta = \dfrac{\sqrt{10}}{3}$, $\cot \theta = 3$
(b) $\sin \theta = -\dfrac{\sqrt{2}}{2}$, $\cos \theta = \dfrac{\sqrt{2}}{2}$, $\tan \theta = -1$, $\csc \theta = -\sqrt{2}$, $\sec \theta = \sqrt{2}$, $\cot \theta = -1$

5. $\sin \theta = \frac{24}{25}$, $\cos \theta = \frac{7}{25}$, $\tan \theta = \frac{24}{7}$, $\csc \theta = \frac{25}{24}$, $\sec \theta = \frac{25}{7}$, $\cot \theta = \frac{7}{24}$

6. $\sin \theta = \frac{15}{17}$, $\cos \theta = \frac{8}{17}$, $\tan \theta = \frac{15}{8}$, $\csc \theta = \frac{17}{15}$, $\sec \theta = \frac{17}{8}$, $\cot \theta = \frac{8}{15}$

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

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

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

8. $\sin\theta = -\frac{2\sqrt{29}}{29}$ $\quad \csc\theta = -\frac{\sqrt{29}}{2}$

$\cos\theta = -\frac{5\sqrt{29}}{29}$ $\quad \sec\theta = -\frac{\sqrt{29}}{5}$

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

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

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

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

10. $\sin\theta = -\frac{31\sqrt{1157}}{1157}$ $\quad \csc\theta = -\frac{\sqrt{1157}}{31}$

$\cos\theta = \frac{14\sqrt{1157}}{1157}$ $\quad \sec\theta = \frac{\sqrt{1157}}{14}$

$\tan\theta = -\frac{31}{14}$ $\quad \cot\theta = -\frac{14}{31}$

11. Quadrant III **12.** Quadrant I

13. Quadrant II **14.** Quadrant IV

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

20. $\sin\theta = \frac{1}{4}$ $\quad \csc\theta = 4$

$\cos\theta = -\frac{\sqrt{15}}{4}$ $\quad \sec\theta = -\frac{4\sqrt{15}}{15}$

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

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

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

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

22. $\sin\theta = 0$ $\quad \csc\theta$ is undefined.

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

$\tan\theta = 0$ $\quad \cot\theta$ is undefined.

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

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

$\tan\theta = 0$ $\quad \cot\theta$ is undefined.

24. $\sin\theta = -1$ $\quad \csc\theta = -1$

$\cos\theta = 0$ $\quad \sec\theta$ is undefined.

$\tan\theta$ is undefined. $\quad \cot\theta = 0$

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

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

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

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

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

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

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

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

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

28. $\sin\theta = -\frac{4}{5}$ $\quad \csc\theta = -\frac{5}{4}$

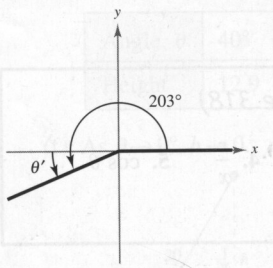
$\cos\theta = \frac{3}{5}$ $\quad \sec\theta = \frac{5}{3}$

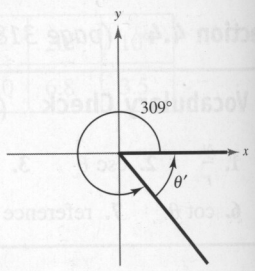
$\tan\theta = -\frac{4}{3}$ $\quad \cot\theta = -\frac{3}{4}$

29. 0 **30.** -1 **31.** Undefined **32.** -1 **33.** 1

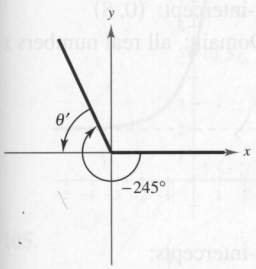
34. Undefined **35.** Undefined **36.** 0

37. $\theta' = 23°$ **38.** $\theta' = 51°$

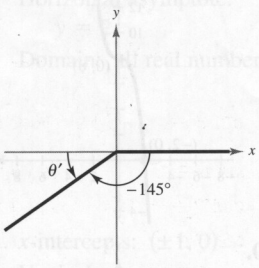




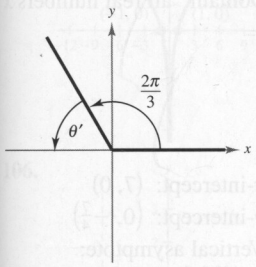
39. $\theta' = 65°$



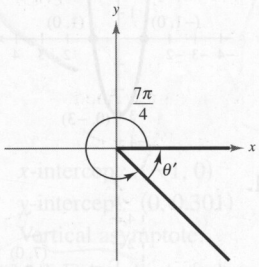
40. $\theta' = 35°$



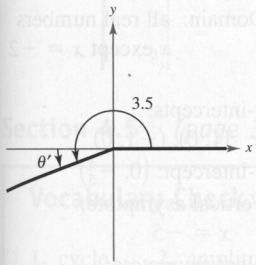
41. $\theta' = \frac{\pi}{3}$



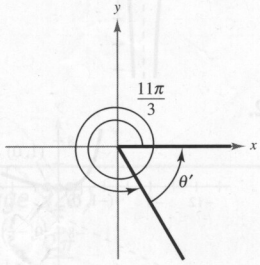
42. $\theta' = \frac{\pi}{4}$



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



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



45. $\sin 225° = -\frac{\sqrt{2}}{2}$

$\cos 225° = -\frac{\sqrt{2}}{2}$

$\tan 225° = 1$

46. $\sin 300° = -\frac{\sqrt{3}}{2}$

$\cos 300° = \frac{1}{2}$

$\tan 300° = -\sqrt{3}$

47. $\sin 750° = \frac{1}{2}$

$\cos 750° = \frac{\sqrt{3}}{2}$

$\tan 750° = \frac{\sqrt{3}}{3}$

48. $\sin(-405°) = -\frac{\sqrt{2}}{2}$

$\cos(-405°) = \frac{\sqrt{2}}{2}$

$\tan(-405°) = -1$

49. $\sin(-150°) = -\frac{1}{2}$

$\cos(-150°) = -\frac{\sqrt{3}}{2}$

$\tan(-150°) = \frac{\sqrt{3}}{3}$

50. $\sin(-840°) = -\frac{\sqrt{3}}{2}$

$\cos(-840°) = -\frac{1}{2}$

$\tan(-840°) = \sqrt{3}$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

56. $\sin\frac{10\pi}{3} = -\frac{\sqrt{3}}{2}$

$\cos\frac{10\pi}{3} = -\frac{1}{2}$

$\tan\frac{10\pi}{3} = \sqrt{3}$

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

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

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

58. $\sin\left(-\frac{25\pi}{4}\right) = -\frac{\sqrt{2}}{2}$

$\cos\left(-\frac{25\pi}{4}\right) = \frac{\sqrt{2}}{2}$

$\tan\left(-\frac{25\pi}{4}\right) = -1$

59. $\frac{4}{5}$ **60.** $\frac{\sqrt{10}}{10}$ **61.** $-\frac{\sqrt{13}}{2}$ **62.** $-\sqrt{3}$ **63.** $\frac{8}{5}$

64. $\frac{\sqrt{65}}{4}$ **65.** 0.1736 **66.** −1.4142 **67.** −0.3420

68. 2.0000 **69.** −1.4826 **70.** −28.6363

71. 3.2361 **72.** −0.1405 **73.** 4.6373 **74.** 0.2245

75. 0.3640 **76.** −0.3640 **77.** −0.6052

78. 1.0436 **79.** −0.4142 **80.** 4.4940

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

82. (a) $45° = \frac{\pi}{4}$, $315° = \frac{7\pi}{4}$ (b) $135° = \frac{3\pi}{4}$, $225° = \frac{5\pi}{4}$

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

84. (a) $60° = \frac{\pi}{3}$, $300° = \frac{5\pi}{3}$ (b) $120° = \frac{2\pi}{3}$, $240° = \frac{4\pi}{3}$

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

86. (a) $60° = \frac{\pi}{3}$, $120° = \frac{2\pi}{3}$ (b) $240° = \frac{4\pi}{3}$, $300° = \frac{5\pi}{3}$

87. (a) $N = 22.099 \sin(0.522t - 2.219) + 55.008$
$F = 36.641 \sin(0.502t - 1.831) + 25.610$
(b) February: $N = 34.6°$, $F = -1.4°$
March: $N = 41.6°$, $F = 13.9°$
May: $N = 63.4°$, $F = 48.6°$
June: $N = 72.5°$, $F = 59.5°$
August: $N = 75.5°$, $F = 55.6°$
September: $N = 68.6°$, $F = 41.7°$
November: $N = 46.8°$, $F = 6.5°$
(c) Answers will vary.

88. (a) 26,134 units (b) 31,438 units (c) 21,452 units
(d) 26,756 units

89. (a) 2 centimeters (b) 0.14 centimeter
(c) -1.98 centimeters

90. (a) 2 centimeters (b) 0.11 centimeter
(c) -1.2 centimeters

91. 0.79 ampere

92. (a) 12 miles (b) 6 miles (c) 6.9 miles

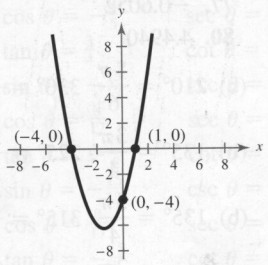
93. False. In each of the four quadrants, the signs of the secant function and cosine function will be the same, because these functions are reciprocals of each other.

94. False. For θ in Quadrant II, $\theta' = 180° - \theta$. For θ in Quadrant III, $\theta' = \theta - 180°$. For θ in Quadrant IV, $\theta' = 360° - \theta$.

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 $\theta = 90°$, the tangent is undefined.

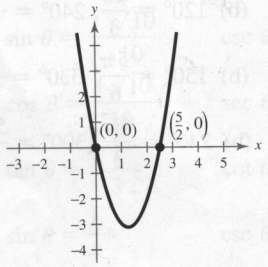
96. Determine the trigonometric function of the reference angle and prefix the appropriate sign.

97.



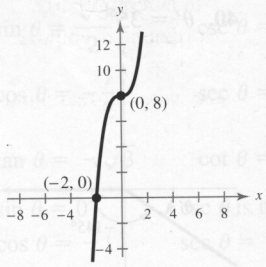
x-intercepts: $(1, 0), (-4, 0)$
y-intercept: $(0, -4)$
Domain: all real numbers x

98.



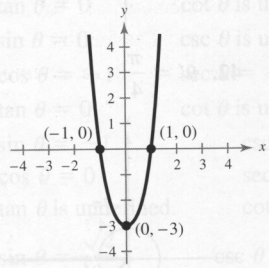
Intercept: $(0, 0)$
x-intercept: $\left(\frac{5}{2}, 0\right)$
Domain: all real numbers x

99.



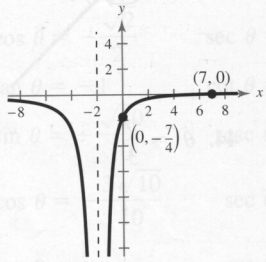
x-intercept: $(-2, 0)$
y-intercept: $(0, 8)$
Domain: all real numbers x

100.



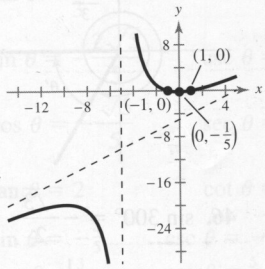
x-intercepts: $(1, 0), (-1, 0)$
y-intercept: $(0, -3)$
Domain: all real numbers x

101.



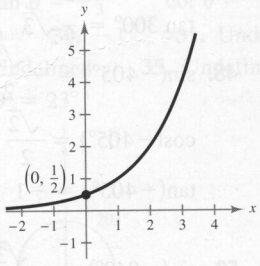
x-intercept: $(7, 0)$
y-intercept: $\left(0, -\frac{7}{4}\right)$
Vertical asymptote: $x = -2$
Horizontal asymptote: $y = 0$
Domain: all real numbers x except $x = -2$

102.

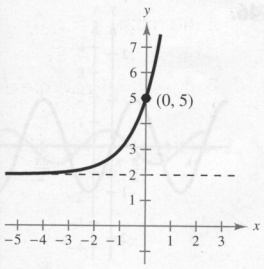


x-intercepts: $(1, 0), (-1, 0)$
y-intercept: $\left(0, -\frac{1}{5}\right)$
Vertical asymptote: $x = -5$
Slant asymptote: $y = x - 5$
Domain: all real numbers x except $x = -5$

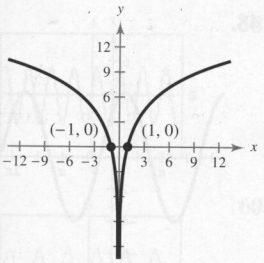
103.



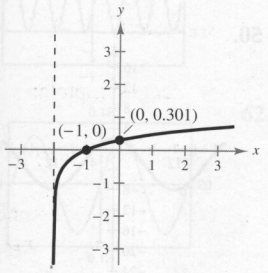
y-intercept: $\left(0, \frac{1}{2}\right)$
Horizontal asymptote: $y = 0$
Domain: all real numbers x

104. 

y-intercept: $(0, 5)$
Horizontal asymptote: $y = 2$
Domain: all real numbers x

105. 

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

106. 

x-intercept: $(-1, 0)$
y-intercept: $(0, 0.301)$
Vertical asymptote: $x = -2$
Domain: all real numbers x such that $x > -2$

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
Amplitude: 3

2. Period: $\frac{2\pi}{3}$
Amplitude: 2

3. Period: 4π
Amplitude: $\frac{5}{2}$

4. Period: 6π
Amplitude: 3

5. Period: 6
Amplitude: $\frac{1}{2}$

6. Period: 4
Amplitude: $\frac{3}{2}$

7. Period: 2π
Amplitude: 3

8. Period: 3π
Amplitude: 1

9. Period: $\frac{\pi}{5}$
Amplitude: 3

10. Period: $\frac{\pi}{4}$
Amplitude: $\frac{1}{3}$

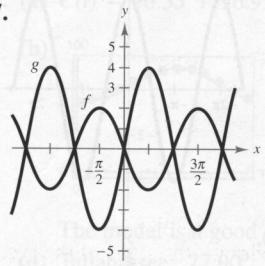
11. Period: 3π
Amplitude: $\frac{1}{2}$

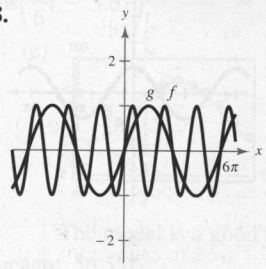
12. Period: 8π
Amplitude: $\frac{5}{2}$

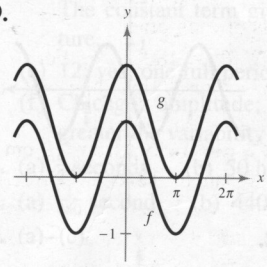
13. Period: 1
Amplitude: $\frac{1}{4}$

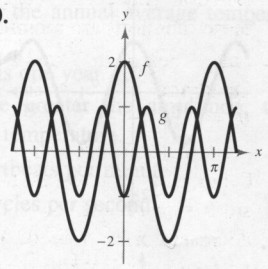
14. Period: 20
Amplitude: $\frac{2}{3}$

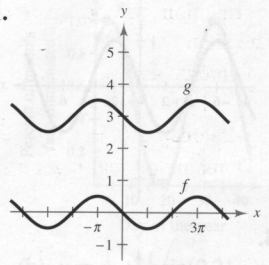
15. g is a shift of f π units to the right.
16. g is a shift of f π units to the left.
17. g is a reflection of f in the x-axis.
18. g is a reflection of f in the x-axis.
19. The period of f is twice the period of g.
20. The period of g is one-third the period of f.
21. g is a shift of f three units upward.
22. g is a shift of f two units downward.
23. The graph of g has twice the amplitude of the graph of f.
24. The period of g is $\frac{1}{3}$ the period of f.
25. The graph of g is a horizontal shift of the graph of f π units to the right.
26. g is a shift of f two units upward.

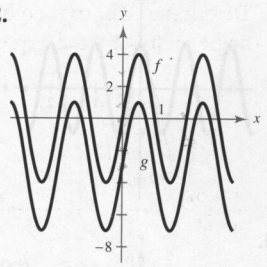
27. 

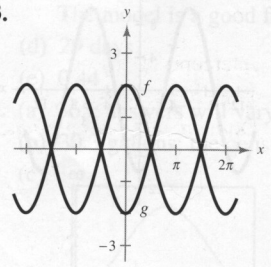
28. 

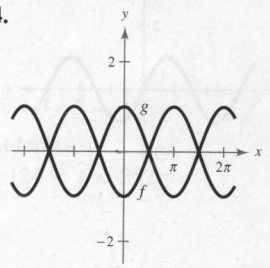
29. 

30. 

31. 

32. 

33. 

34. 

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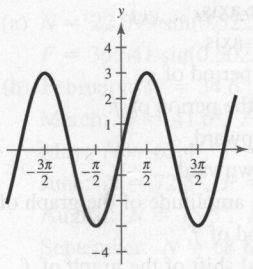

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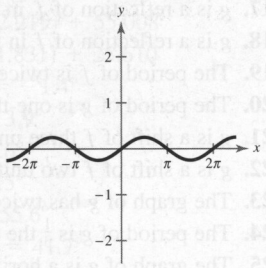

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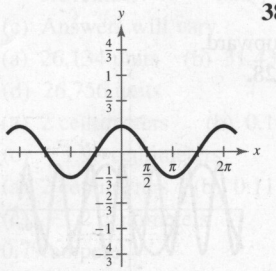

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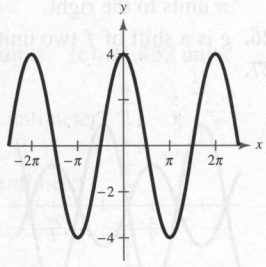

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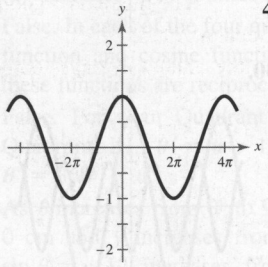

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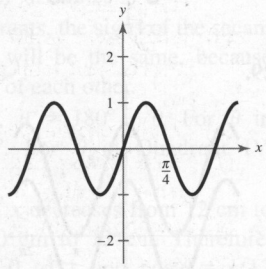

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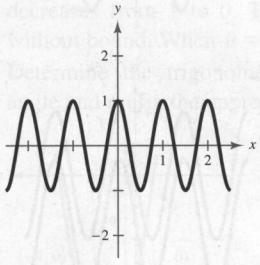

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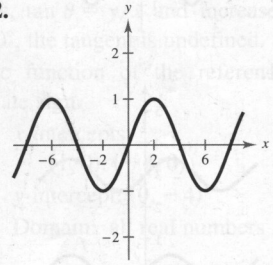

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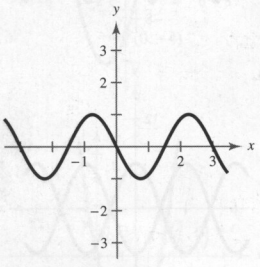

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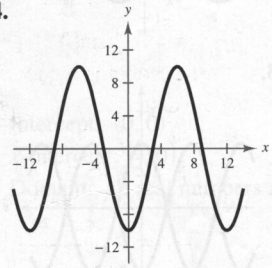

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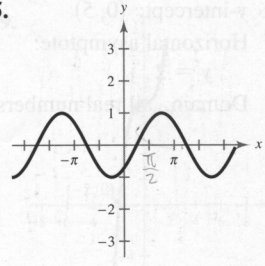

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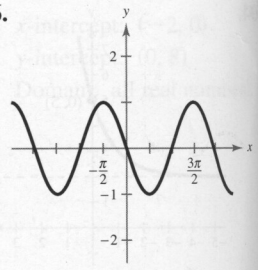

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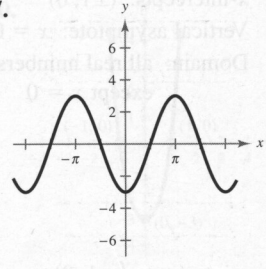

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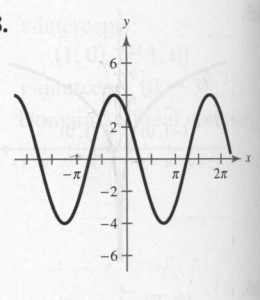

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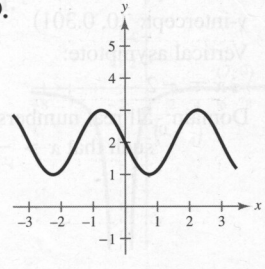

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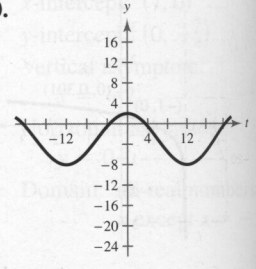

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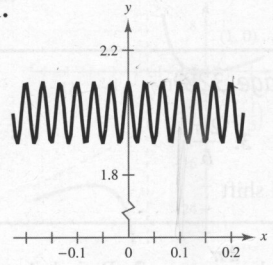

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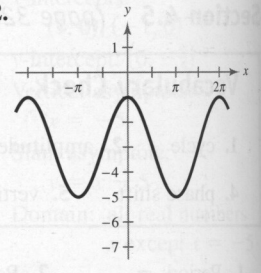

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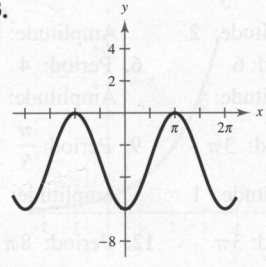

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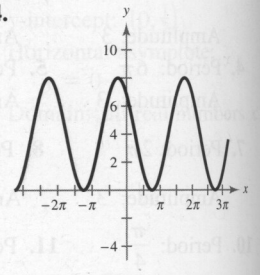

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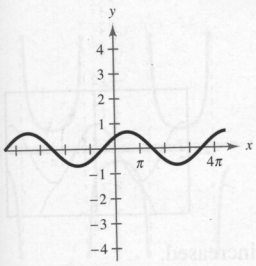

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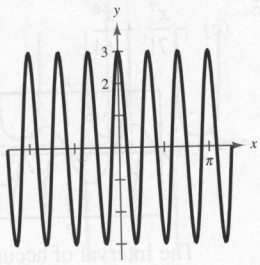

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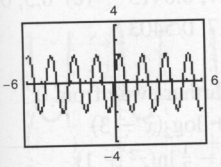

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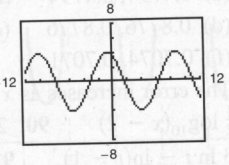

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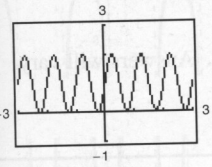

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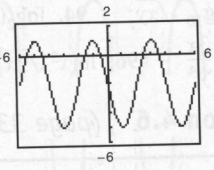
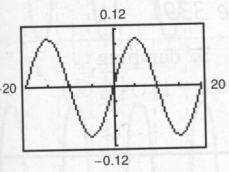
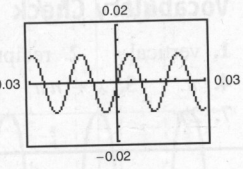


61.



62.



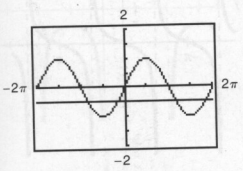
63. $a = 2, d = 1$ **64.** $a = 2, d = -1$

65. $a = -4, d = 4$ **66.** $a = -1, d = -3$

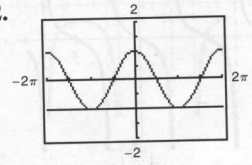
67. $a = -3, b = 2, c = 0$ **68.** $a = 2, b = \frac{1}{2}, c = 0$

69. $a = 2, b = 1, c = -\frac{\pi}{4}$ **70.** $a = 2, b = \frac{\pi}{2}, c = -\frac{\pi}{2}$

71.



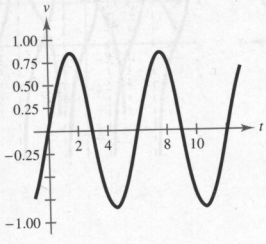
72.



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

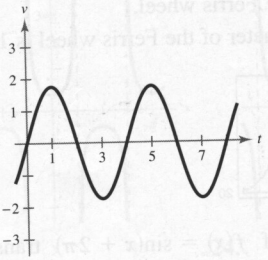
73. (a) 6 seconds (b) 10 cycles per minute

(c)



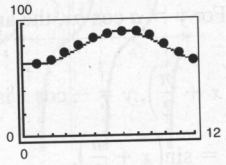
74. (a) 4 seconds (b) 15 cycles per minute

(c)



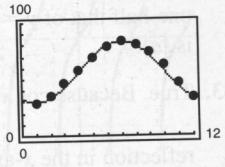
75. (a) $C(t) = 56.55 + 26.95 \cos\left(\frac{\pi}{6}t - 3.67\right)$

(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.

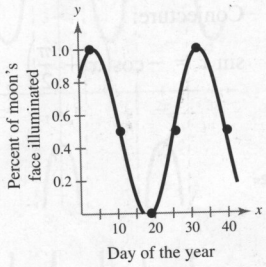
(e) 12; yes; one full period is one year.

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

76. (a) $\frac{6}{5}$ seconds (b) 50 heartbeats per minute

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

78. (a)–(c)



(b) $y = \frac{1}{2} + \frac{1}{2}\sin(0.21x + 0.92)$
The model is a good fit.

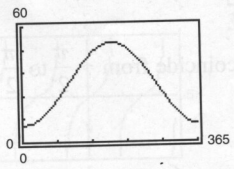
(d) 29 days

(e) 0.44

79. (a) 365; answers will vary.

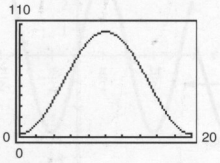
(b) 30.3 gallons; the constant term

(c) $124 < t < 252$



80. (a) 20 seconds; it takes 20 seconds to complete one revolution on the Ferris wheel.

(b) 50 feet; the diameter of the Ferris wheel is 100 feet.

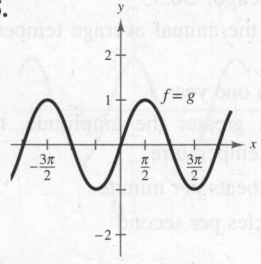
(c) 

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.

82. False. The function $y = \frac{1}{2}\cos 2x$ has an amplitude that is one-half that of $y = \cos x$. For $y = a\cos bx$, the amplitude is $|a|$.

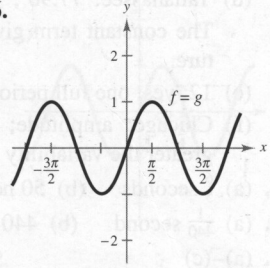
83. True. Because $\cos x = \sin\left(x + \frac{\pi}{2}\right)$, $y = -\cos x$ is a reflection in the x-axis of $y = \sin\left(x + \frac{\pi}{2}\right)$.

84. Answers will vary.

85. 

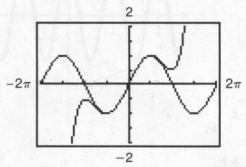
Conjecture:

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

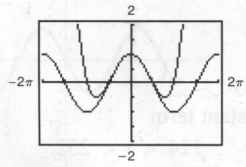
86. 

Conjecture:

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

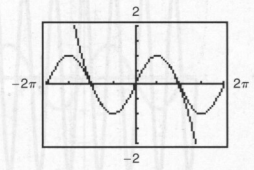
87. (a) 

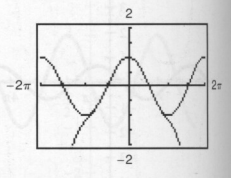
The graphs appear to coincide from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$.

(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.

88. (a) 0.4794, 0.4794 (b) 0.8417, 0.8415 (c) 0.5, 0.5
(d) 0.8776, 0.8776 (e) 0.5417, 0.5403
(f) 0.7074, 0.7071

The error increases as x moves farther away from 0.

89. $\frac{1}{2}\log_{10}(x - 2)$ **90.** $2\log_2 x + \log_2(x - 3)$

91. $3\ln t - \ln(t - 1)$ **92.** $\frac{1}{2}\ln z - \frac{1}{2}\ln(z^2 + 1)$

93. $\log_{10}\sqrt{xy}$ **94.** $\log_2(x^3y)$

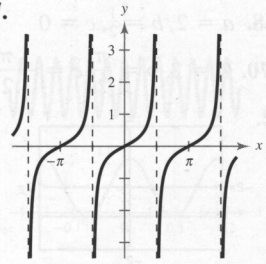
95. $\ln\frac{3x}{y^4}$ **96.** $\ln\left(x^2\sqrt{2x}\right)$ **97.** Answers will vary.

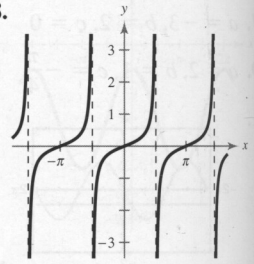
Section 4.6 *(page 339)*

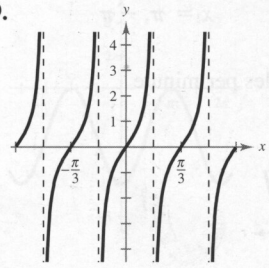
Vocabulary Check *(page 339)*

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

7. 

8. 

9. 

10.