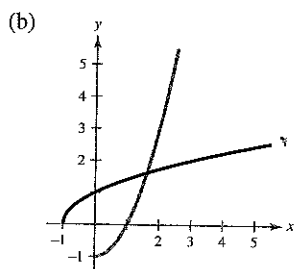


67. (a) $f^{-1}(x) = x^2 - 1, x \geq 0$



(c) $f^{-1}(f(x)) = f^{-1}(\sqrt{x+1})$
 $= (x+1) - 1$
 $= x$

$f(f^{-1}(x)) = f(x^2 - 1), x \geq 0$
 $= \sqrt{x^2 - 1 + 1}$
 $= x$

69. $x \geq 4, f^{-1}(x) = \sqrt{\frac{x}{2}} + 4$

71. $x \geq 2, f^{-1}(x) = \sqrt{x^2 + 4}, x \geq 0$

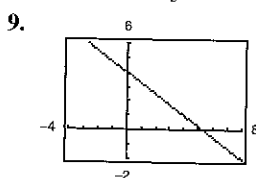
73. -7 75. 5 77. 23 79. 9

Chapter Test (page 114)

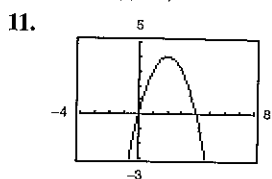
1. $-\frac{10}{3} > -|-4|$ 2. (a) $\frac{35}{24}$ (b) 28 3. $\frac{128}{11}$

4. No solution 5. $\frac{-3 \pm \sqrt{3}}{3}$ 6. $\pm\sqrt{2}$

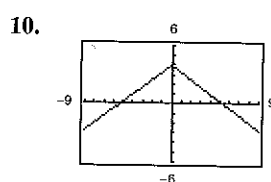
7. 4 8. $-2, \frac{8}{3}$



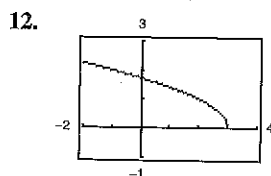
No symmetry
 $(0, 4), (\frac{16}{3}, 0)$



No symmetry
 $(0, 0), (4, 0)$



y-axis symmetry
 $(0, 4), (\pm\frac{16}{3}, 0)$



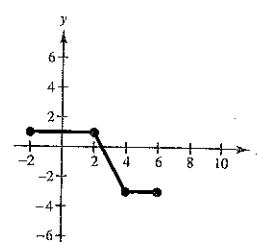
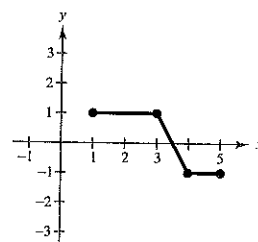
No symmetry
 $(0, \sqrt{3}), (3, 0)$

13. (a) $2x + 3y - 12 = 0$ (b) $y + 2 = 0$

14. No. For some values of x there correspond more than one value of y .

15. $g(t) = 10 - \sqrt{6-t}, (-\infty, 6]$

16. (a) (b)



17. $x^2 - \sqrt{2-x}$ 18. $\frac{x^2}{\sqrt{2-x}}$ 19. $2-x, x \leq 2$

20. $2-x^2$ 21. $93\frac{3}{4}$ kilometers per hour

CHAPTER 1**Section 1.1 (page 123)****Warm Up (page 123)**

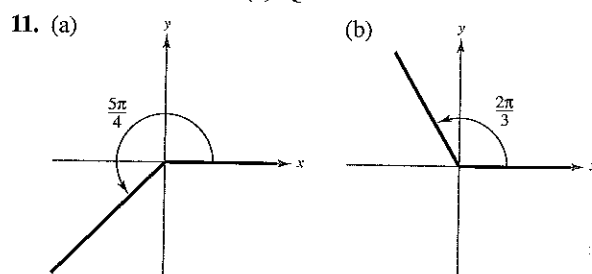
1. 45 2. 70 3. $\frac{\pi}{6}$ 4. $\frac{\pi}{3}$ 5. $\frac{\pi}{4}$ 6. $\frac{4\pi}{3}$

7. $\frac{\pi}{9}$ 8. $\frac{11\pi}{6}$ 9. 45 10. 45

1. 2 3. -3 5. (a) Quadrant I (b) Quadrant III

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

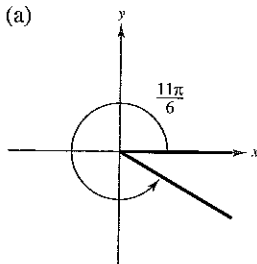
9. (a) Quadrant III (b) Quadrant II



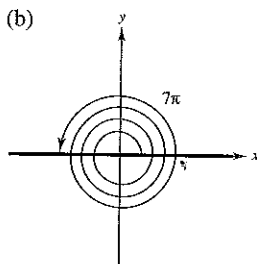
Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A69

13. (a)



(b)



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

17. (a) $\frac{7\pi}{4}, -\frac{\pi}{4}$ (b) $\frac{28\pi}{15}, -\frac{32\pi}{15}$

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

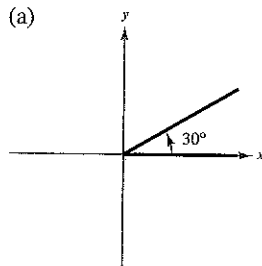
(b) Complement: none; Supplement: $\frac{\pi}{4}$

21. 210° 23. -45°

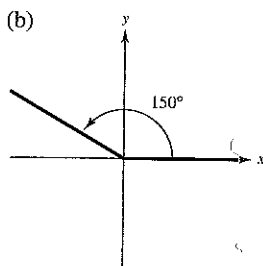
25. (a) Quadrant II (b) Quadrant IV

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

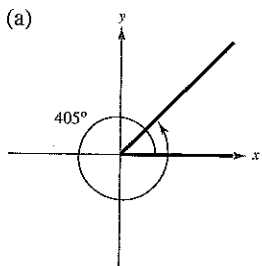
29. (a)



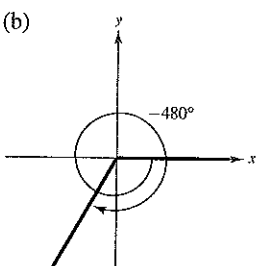
(b)



31. (a)



(b)



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

35. (a) $660^\circ, -60^\circ$ (b) $20^\circ, -340^\circ$

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

(b) Complement: none; Supplement: 65°

39. (a) $\frac{\pi}{6}$ (b) $\frac{5\pi}{6}$ 41. (a) $-\frac{\pi}{9}$ (b) $-\frac{4\pi}{3}$

43. (a) 270° (b) 210° 45. (a) 420° (b) -66°

47. 2.007 49. -3.776 51. 9.285 53. -0.014

55. 25.714° 57. 337.5° 59. -756°

61. -114.592° 63. (a) 54.75° (b) -128.5°

65. (a) 85.308° (b) 330.007°

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

69. (a) $143^\circ 14' 22''$ (b) $-205^\circ 7' 8''$

71. $\frac{6}{5}$ rad 73. $4\frac{4}{7}$ rad 75. $\frac{4}{15}$ rad 77. $\frac{50}{29}$ rad

79. 15π inches ≈ 47.12 inches 81. 12 meters

83. 591.72 miles 85. 1141.02 miles

87. 0.094 rad $\approx 5.39^\circ$ 89. $\frac{5}{12}$ rad

91. (a) 560.2 revolutions per minute

(b) 3520 rad per minute

93. Radian. 1 rad $\approx 57.3^\circ$

95. 20.16π inches per second

97. Answers will vary. 99. ≈ 2.16 miles

Section 1.2 (page 133)

Warm Up (page 133)

1. $-\frac{\sqrt{3}}{3}$ 2. -1 3. $\frac{2\pi}{3}$ 4. $\frac{7\pi}{4}$ 5. $\frac{\pi}{6}$

6. $\frac{3\pi}{4}$ 7. 60° 8. -270° 9. 2π 10. π

1. $\sin t = \frac{4}{5}$

$\cos t = -\frac{3}{5}$

$\tan t = -\frac{4}{3}$

$\csc t = \frac{5}{4}$

$\sec t = -\frac{5}{3}$

$\cot t = -\frac{3}{4}$

3. $\sin t = -\frac{15}{17}$

$\cos t = \frac{8}{17}$

$\tan t = -\frac{15}{8}$

$\csc t = -\frac{17}{15}$

$\sec t = \frac{17}{8}$

$\cot t = -\frac{8}{15}$

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

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

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

17. $\sin \left(-\frac{5\pi}{4}\right) = \frac{\sqrt{2}}{2}$

$\cos \left(-\frac{5\pi}{4}\right) = -\frac{\sqrt{2}}{2}$

$\tan \left(-\frac{5\pi}{4}\right) = -1$

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

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

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

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

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

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

$\csc \frac{3\pi}{4} = \sqrt{2}$

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

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

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

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

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

19. $\sin \frac{11\pi}{6} = -\frac{1}{2}$

$\cos \frac{11\pi}{6} = \frac{\sqrt{3}}{2}$

$\tan \frac{11\pi}{6} = -\frac{\sqrt{3}}{3}$

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

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

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

27. $\sin \frac{\pi}{2} = 1$

$\cos \frac{\pi}{2} = 0$

$\tan \frac{\pi}{2}$ is undefined.

$\csc \frac{\pi}{2} = 1$

$\sec \frac{\pi}{2}$ is undefined.

$\cot \frac{\pi}{2} = 0$

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

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

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

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

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

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

31. $\sin 3\pi = \sin \pi = 0$

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

35. $\cos \frac{19\pi}{6} = \cos \frac{7\pi}{6} = -\frac{\sqrt{3}}{2}$

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

39. (a) $-\frac{1}{3}$ (b) -3

41. (a) $-\frac{7}{8}$ (b) $-\frac{8}{7}$ 43. (a) $\frac{4}{5}$ (b) $-\frac{4}{5}$

45. 0.7071 47. -0.9900 49. -0.1288

51. 1.3940 53. -1.4486 55. (a) -1 (b) -0.4

57. (a) 0.25, 2.89 (b) 1.82, 4.46

59. $0.0707 = \cos 1.5 \neq 2 \cos 0.75 = 1.4634$

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

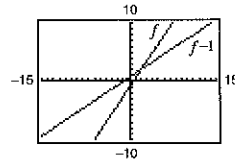
(c) $\cos(\pi - t_1) = -\cos t_1$

63. (a) 0.2500 foot (b) 0.0177 foot (c) -0.2475 foot

65. 0.794 67. Odd

69. $f^{-1}(x) = \frac{2}{3}(x + 1)$

$f(x) = \frac{1}{2}(3x - 2)$

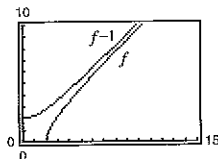


Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A71

71. $f^{-1}(x) = \sqrt{x^2 + 4}, \quad x \geq 0$

$f(x) = \sqrt{x^2 - 4}, \quad x \geq 2$



Section 1.3 (page 143)

Warm Up (page 143)

1. $2\sqrt{5}$ 2. $3\sqrt{10}$ 3. 10 4. $3\sqrt{2}$ 5. 1.24

6. 317.55 7. 63.13 8. 133.57

9. 2,785,714.29 10. 28.80

1. $\sin \theta = \frac{1}{2}$

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

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

$\csc \theta = 2$

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

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

5. $\sin \theta = \frac{1}{3}$

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

$\tan \theta = \frac{\sqrt{2}}{4}$

$\csc \theta = 3$

$\sec \theta = \frac{3\sqrt{2}}{4}$

$\cot \theta = 2\sqrt{2}$

The triangles are similar, and corresponding sides are proportional.

3. $\sin \theta = \frac{8}{17}$

$\cos \theta = \frac{15}{17}$

$\tan \theta = \frac{8}{15}$

$\csc \theta = \frac{17}{8}$

$\sec \theta = \frac{17}{15}$

$\cot \theta = \frac{15}{8}$

7. $\sin \theta = \frac{3}{5}$

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

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

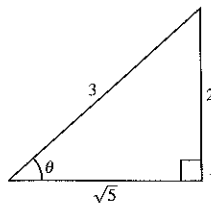
$\csc \theta = \frac{5}{3}$

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

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

The triangles are similar, and corresponding sides are proportional.

9.



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

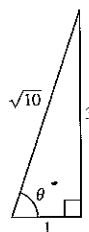
$\tan \theta = \frac{2\sqrt{5}}{5}$

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

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

$\cot \theta = \frac{\sqrt{5}}{2}$

13.



$\sin \theta = \frac{3\sqrt{10}}{10}$

$\cos \theta = \frac{\sqrt{10}}{10}$

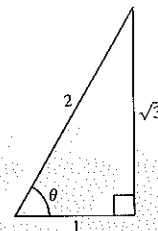
$\csc \theta = \frac{\sqrt{10}}{3}$

$\sec \theta = \sqrt{10}$

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

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

11.



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

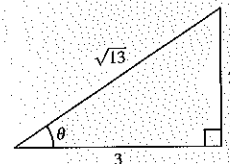
$\cos \theta = \frac{1}{2}$

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

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

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

15.



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

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

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

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

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

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

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

23.–31. Answers will vary.

33. (a) $\frac{1}{2}$ (b) $\frac{\sqrt{3}}{3}$ 35. (a) 1 (b) $\frac{\sqrt{2}}{2}$

37. (a) 0.1736 (b) 0.1736 39. (a) 0.2815 (b) 3.5523

41. (a) 1.3499 (b) 1.3432 43. (a) 5.0273 (b) 0.1989

45. (a) 1.1884 (b) 0.5463

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

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

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

53. (a) $55^\circ \approx 0.960$ (b) $89^\circ \approx 1.553$

55. (a) $50^\circ \approx 0.873$ (b) $25^\circ \approx 0.436$ 57. $25\sqrt{3}$

59. $\frac{32\sqrt{3}}{3}$ 61. 23.3 63. 6.1 65. $17\frac{1}{4}$ feet

67. (a)  (b) $\sin 75^\circ = \frac{x}{30}$
(c) 29.0 meters

69. 1144.9 feet 71. $(x_1, y_1) = (28\sqrt{3}, 28)$
 $(x_2, y_2) = (28, 28\sqrt{3})$

73. $\sin 20^\circ \approx 0.34$
 $\cos 20^\circ \approx 0.94$
 $\tan 20^\circ \approx 0.36$
 $\csc 20^\circ \approx 2.92$
 $\sec 20^\circ \approx 1.06$
 $\cot 20^\circ \approx 2.75$

75. (a)

θ	0	0.1	0.2	0.3	0.4	0.5
$\sin \theta$	0	0.0998	0.1987	0.2955	0.3894	0.4794

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

77. True, $\csc x = \frac{1}{\sin x}$ 79. False, $\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2} \neq 1$

81. False, $1.7321 \neq 0.0349$ 83. $\frac{x}{x-2}$

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

Section 1.4 (page 154)

Warm Up (page 154)

1. $\frac{1}{2}$ 2. 1 3. $\frac{\sqrt{2}}{2}$ 4. $\frac{\sqrt{3}}{3}$ 5. $\frac{2\sqrt{3}}{3}$ 6. $\sqrt{2}$

7. $\sin \theta = \frac{3\sqrt{13}}{13}$

8. $\sin \theta = \frac{\sqrt{5}}{3}$

$\cos \theta = \frac{2\sqrt{13}}{13}$

$\tan \theta = \frac{\sqrt{5}}{2}$

$\csc \theta = \frac{\sqrt{13}}{3}$

$\csc \theta = \frac{3\sqrt{5}}{5}$

$\sec \theta = \frac{\sqrt{13}}{2}$

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

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

$\cot \theta = \frac{2\sqrt{5}}{5}$

9. $\cos \theta = \frac{2\sqrt{6}}{5}$

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

$\tan \theta = \frac{\sqrt{6}}{12}$

$\cos \theta = \frac{1}{3}$

$\csc \theta = 5$

$\tan \theta = 2\sqrt{2}$

$\sec \theta = \frac{5\sqrt{6}}{12}$

$\csc \theta = \frac{3\sqrt{2}}{4}$

$\cot \theta = 2\sqrt{6}$

$\cot \theta = \frac{\sqrt{2}}{4}$

period: _____

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A73

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

3. (a) $\sin \theta = -\frac{1}{2}$
 $\cos \theta = -\frac{\sqrt{3}}{2}$
 $\tan \theta = \frac{\sqrt{3}}{3}$
 $\csc \theta = -2$
 $\sec \theta = -\frac{2\sqrt{3}}{3}$
 $\cot \theta = \sqrt{3}$

(b) $\sin \theta = \frac{\sqrt{2}}{2}$
 $\cos \theta = -\frac{\sqrt{2}}{2}$
 $\tan \theta = -1$
 $\csc \theta = \sqrt{2}$
 $\sec \theta = -\sqrt{2}$
 $\cot \theta = -1$

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

(b) $\sin \theta = -\frac{24}{25}$
 $\cos \theta = \frac{7}{25}$
 $\tan \theta = -\frac{24}{7}$
 $\csc \theta = -\frac{25}{24}$
 $\sec \theta = \frac{25}{7}$
 $\cot \theta = -\frac{7}{24}$

7. (a) $\sin \theta = \frac{5\sqrt{29}}{29}$
 $\cos \theta = -\frac{2\sqrt{29}}{29}$
 $\tan \theta = -\frac{5}{2}$
 $\csc \theta = \frac{\sqrt{29}}{5}$
 $\sec \theta = -\frac{\sqrt{29}}{2}$
 $\cot \theta = -\frac{2}{5}$

(b) $\sin \theta = -\frac{5\sqrt{34}}{34}$
 $\cos \theta = \frac{3\sqrt{34}}{34}$
 $\tan \theta = -\frac{5}{3}$
 $\csc \theta = -\frac{\sqrt{34}}{5}$
 $\sec \theta = \frac{\sqrt{34}}{3}$
 $\cot \theta = -\frac{3}{5}$

9. (a) Quadrant III

(b) Quadrant II

11. (a) Quadrant II

(b) Quadrant IV

13. $\sin \theta = \frac{3}{5}$

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

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

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

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

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

$\csc \theta = \frac{5}{3}$

$\csc \theta = -\frac{17}{15}$

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

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

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

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

17. $\sin \theta = -\frac{\sqrt{10}}{10}$

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

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

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

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

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

$\csc \theta = -\sqrt{10}$

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

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

$\sec \theta = -2$

$\cot \theta = -3$

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

21. $\sin \theta = 0$

$\cos \theta = -1$

$\tan \theta = 0$

$\csc \theta$ is undefined.

$\sec \theta = -1$

$\cot \theta$ is undefined.

23. $\sin \theta = \frac{\sqrt{2}}{2}$

25. $\sin \theta = \frac{2\sqrt{5}}{5}$

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

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

$\tan \theta = -1$

$\tan \theta = 2$

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

$\csc \theta = -\frac{\sqrt{5}}{2}$

$\sec \theta = -\sqrt{2}$

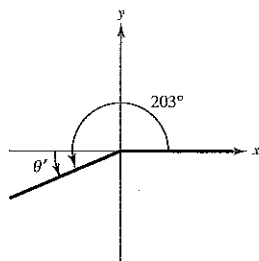
$\sec \theta = -\sqrt{5}$

$\cot \theta = -1$

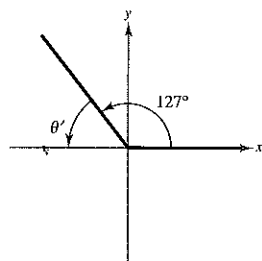
$\cot \theta = \frac{1}{2}$

27. -1 29. -1 31. Undefined 33. 0

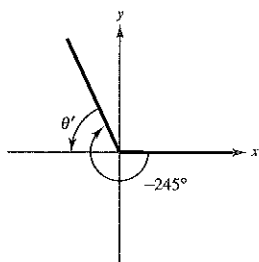
35. (a) $\theta' = 23^\circ$



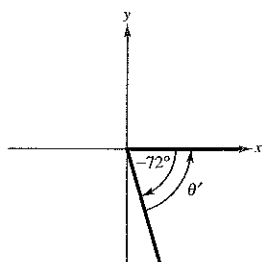
(b) $\theta' = 53^\circ$



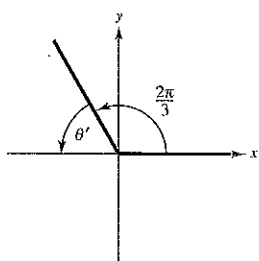
37. (a) $\theta' = 65^\circ$



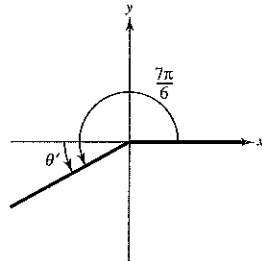
(b) $\theta' = 72^\circ$



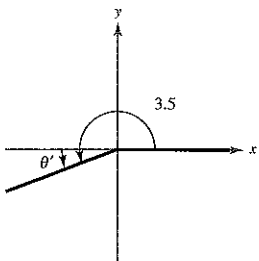
39. (a) $\theta' = \frac{\pi}{3}$



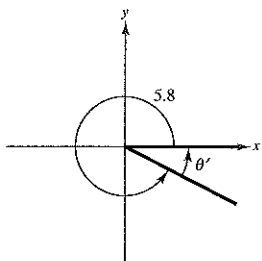
(b) $\theta' = \frac{\pi}{6}$



41. (a) $\theta' = 3.5 - \pi$



(b) $\theta' = 2\pi - 5.8$



43. (a) $\sin 225^\circ = -\frac{\sqrt{2}}{2}$

(b) $\sin(-225^\circ) = \frac{\sqrt{2}}{2}$

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

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

$\tan 225^\circ = 1$

$\tan(-225^\circ) = -1$

45. (a) $\sin 750^\circ = \frac{1}{2}$

(b) $\sin 510^\circ = \frac{1}{2}$

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

$\cos 510^\circ = -\frac{\sqrt{3}}{2}$

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

$\tan 510^\circ = -\frac{\sqrt{3}}{3}$

47. (a) $\sin \frac{4\pi}{3} = -\frac{\sqrt{3}}{2}$

(b) $\sin \frac{2\pi}{3} = \frac{\sqrt{3}}{2}$

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

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

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

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

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

(b) $\sin\left(\frac{5\pi}{6}\right) = \frac{1}{2}$

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

$\cos\left(\frac{5\pi}{6}\right) = -\frac{\sqrt{3}}{2}$

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

$\tan\left(\frac{5\pi}{6}\right) = -\frac{\sqrt{3}}{3}$

51. (a) $\sin \frac{11\pi}{4} = \frac{\sqrt{2}}{2}$

(b) $\sin\left(-\frac{13\pi}{6}\right) = -\frac{1}{2}$

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

$\cos\left(-\frac{13\pi}{6}\right) = \frac{\sqrt{3}}{2}$

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

$\tan\left(-\frac{13\pi}{6}\right) = -\frac{\sqrt{3}}{3}$

53. (a) 0.1736 (b) 5.7588

55. (a) -0.3420 (b) -0.3420

57. (a) 1.7321 (b) 1.7321

59. (a) 0.3640 (b) 0.3640

61. (a) 0.6052 (b) 0.6077

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

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

period: _____

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A75

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

69. (a) 54.99° , 125.01° (b) 195.00° , 345.00°

71. (a) 0.175, 6.109 (b) 2.201, 4.083

73. (a) 0.873, 4.014 (b) 1.693, 4.835

75. $\frac{4}{5}$ 77. $-\frac{\sqrt{13}}{2}$ 79. $\frac{8}{5}$

81. (a) 25.2°F (b) 65.1°F (c) 50.8°F

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

Section 1.5 (page 166)

Warm Up (page 166)

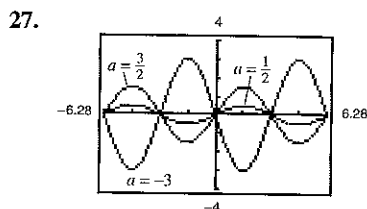
- | | | | | | |
|-----------|------------------|--------------------|---------------------|---------|-------------------|
| 1. 6π | 2. $\frac{1}{2}$ | 3. $\frac{\pi}{6}$ | 4. $\frac{7\pi}{6}$ | 5. -2 | 6. $-\frac{4}{3}$ |
| 7. 1 | 8. 0 | 9. 1 | 10. 0 | | |

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

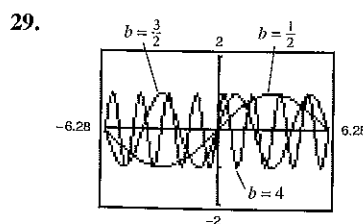
7. Period: 2π 9. Period: $\frac{\pi}{5}$
 Amplitude: 2 Amplitude: 3

11. Period: 3π 13. Period: $\frac{1}{2}$
 Amplitude: $\frac{1}{2}$ Amplitude: 3

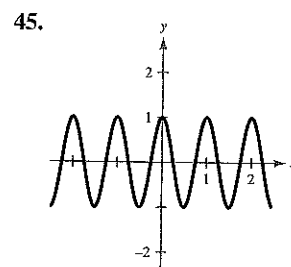
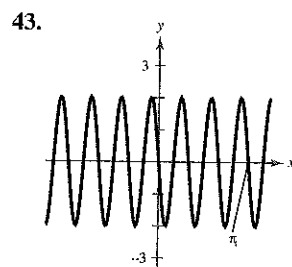
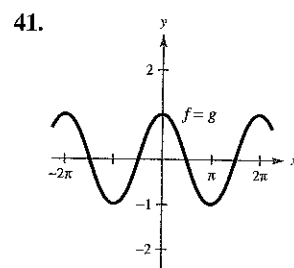
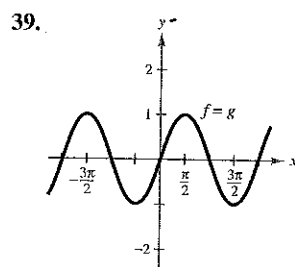
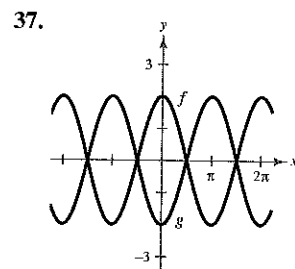
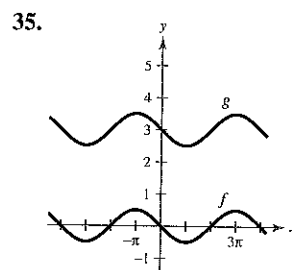
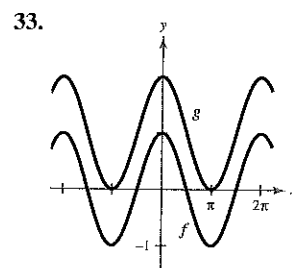
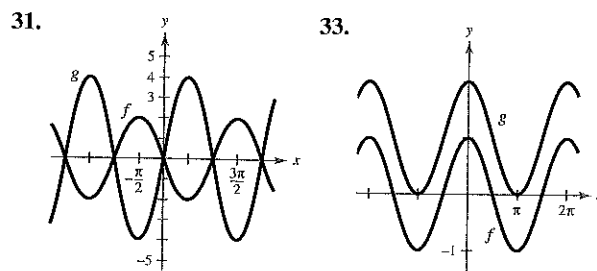
15. g is a shift of f π units to the right.
 17. g is a reflection of f about the x -axis.
 19. The period of f is twice the period of g .
 21. Shift the graph of f two units up to obtain the graph of g .
 23. The graph of g has twice the amplitude of the graph of f .
 25. The graph of g is a horizontal shift of the graph of f π units to the right.



Amplitude changes

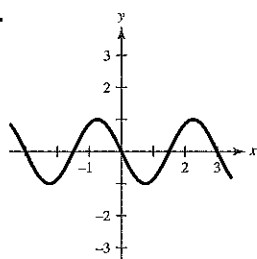


Period changes

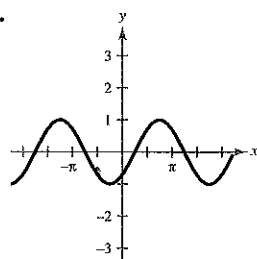


A76 **Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests**

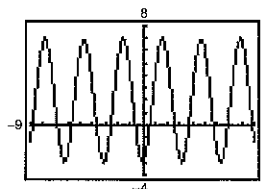
47.



49.



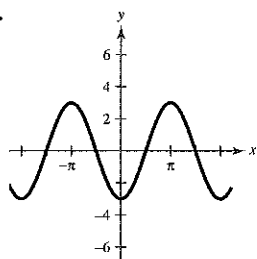
67.



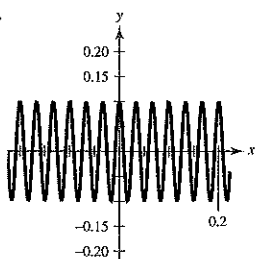
69. $y = 2 + 3 \cos x$ 71. $y = -4 \cos x + 4$

73. $y = -3 \sin(2x)$ 75. $y = \sin\left(x - \frac{\pi}{4}\right)$

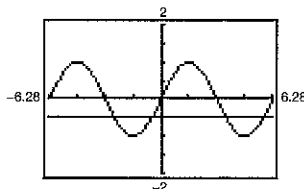
51.



53.

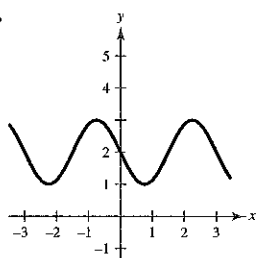


77.

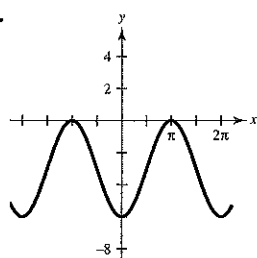


$x = -\frac{\pi}{6}, -\frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

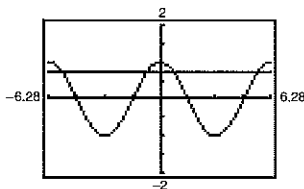
55.



57.

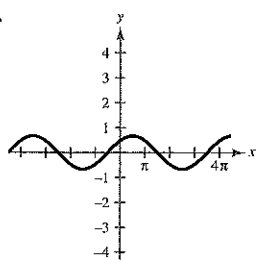


79.

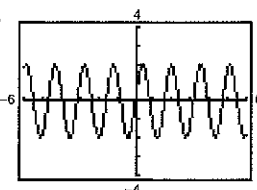


$x = \pm \frac{\pi}{4}, \pm \frac{7\pi}{4}$

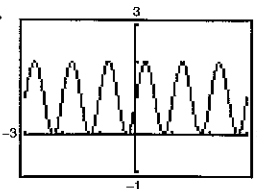
59.



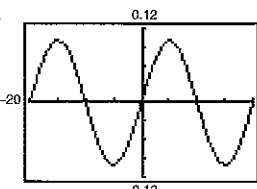
61.



63.



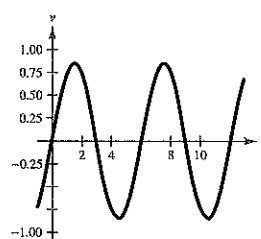
65.



81. (a) Even (b) Even

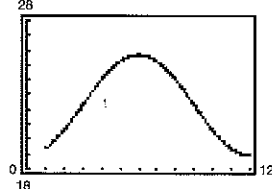
83. (a) 6 seconds (b) 10 cycles per minute

(c)



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

87.

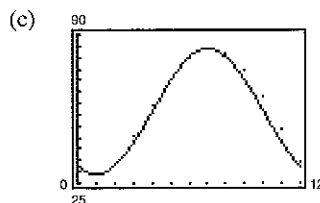
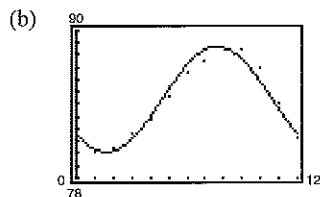


period: _____

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A77

89. (a) $C(t) = 56.35 + 27.35 \sin\left(\frac{\pi t}{6} + 4.19\right)$

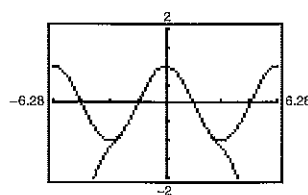
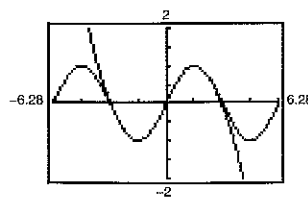


(d) Honolulu: 84.40; Chicago: 56.35. Vertical translation (d)

(e) 12. Yes. One full period is 1 year.

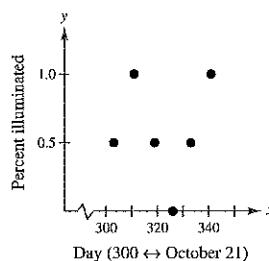
(f) Chicago, amplitude

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

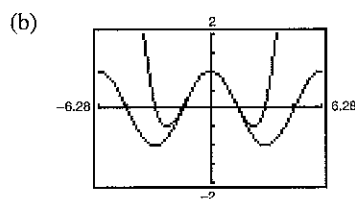


The accuracy increased.

93. (a)

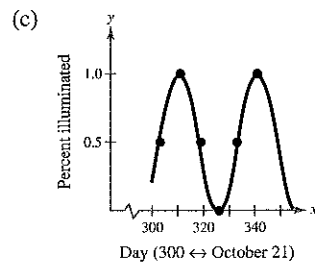


They appear to coincide from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$.



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

(b) $y = \frac{1}{2} + \frac{1}{2} \sin\left[\frac{\pi}{15}(t - 303)\right]$



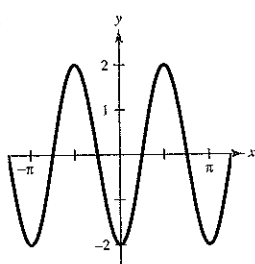
(d) 0

Section 1.6 (page 171)

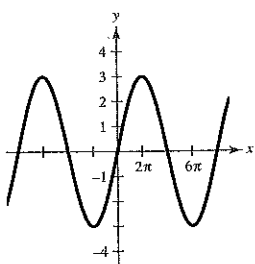
Warm Up (page 171)

1. 0 2. $\frac{\sqrt{2}}{2}$ 3. 1 4. 0 5. 0 6. 0

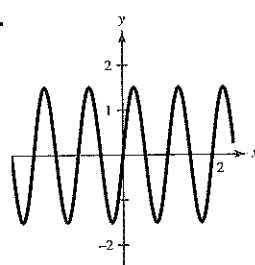
7.



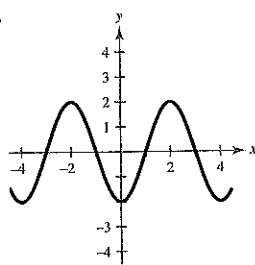
8.



9.

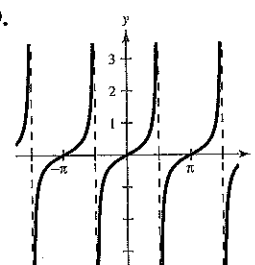


10.

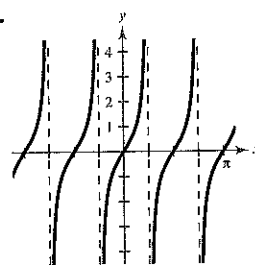


1. g, 4π 3. f, $\frac{\pi}{2}$ 5. b, 2 7. e, 2π

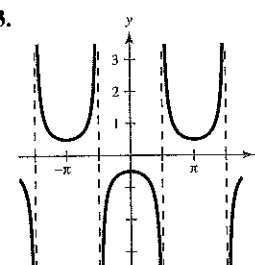
9.



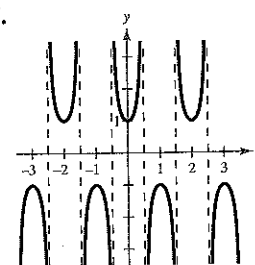
11.



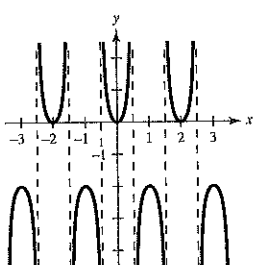
13.



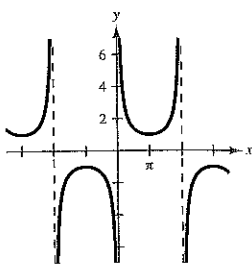
15.



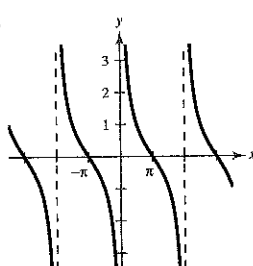
17.



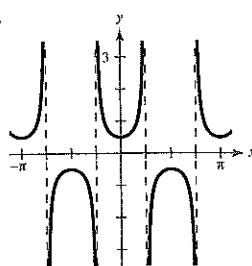
19.



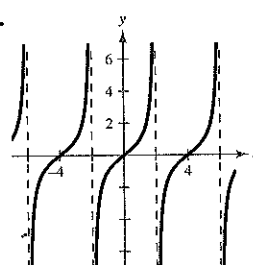
21.



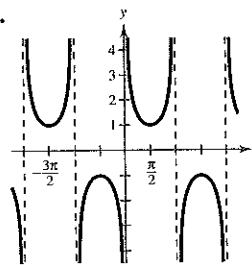
23.



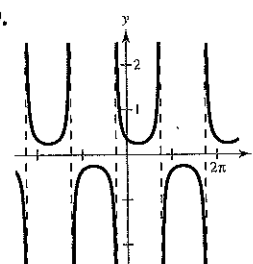
25.



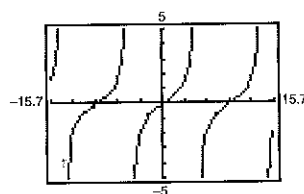
27.



29.



31.

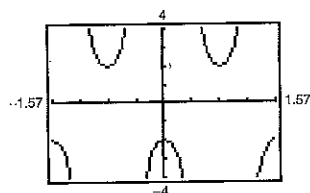


_____ period: _____

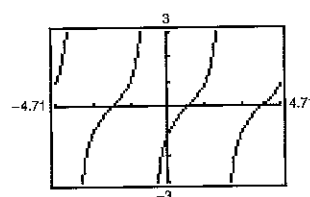
Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A79

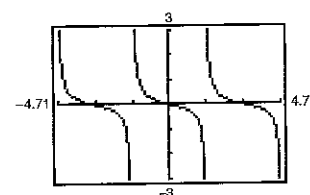
33.



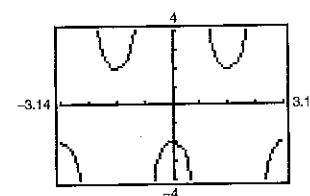
35.



37.



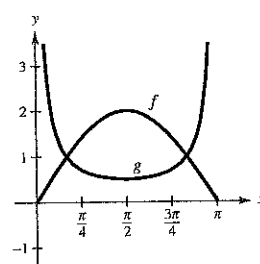
39.



41. $\frac{7\pi}{4}, \frac{3\pi}{4}, \frac{\pi}{4}, \frac{5\pi}{4}$ 43. $-\frac{4\pi}{3}, \frac{2\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}$

45. Even 47. As x approaches $\pi/2$ from the left, f approaches ∞ . As x approaches $\pi/2$ from the right, f approaches $-\infty$.

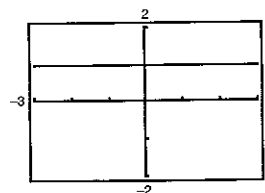
49. (a)



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

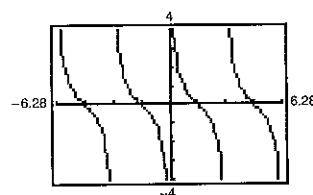
(c) Sine approaches 0 and cosecant approaches $\pm\infty$ because the cosecant is the reciprocal of the sine.

51.



Not equivalent

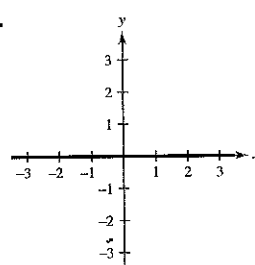
53.



Equivalent

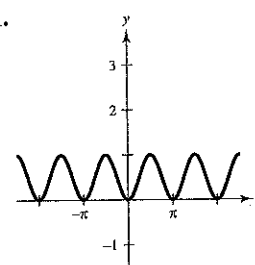
55. d, 0 57. b, 0

59.



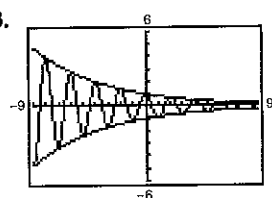
Equal

61.



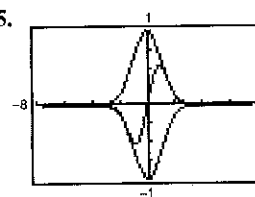
Equal

63.



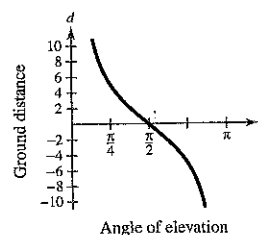
0

65.

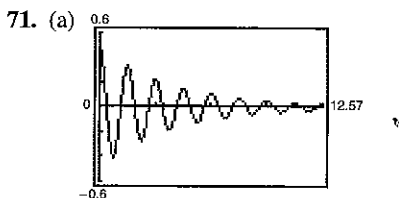


0

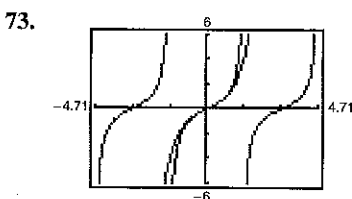
67. $d = 5 \cot x$



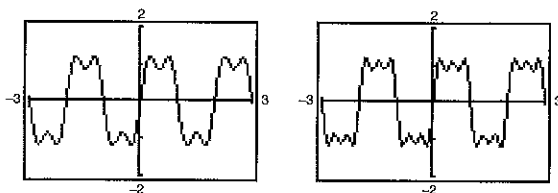
69. As the predator population increases, the number of prey decreases. When the number of prey is small, the number of predators decreases.



- (b) Damped sine wave; goes to 0 as t increases.

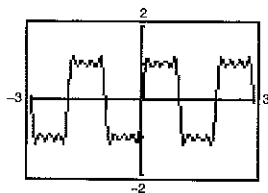


75. (a)



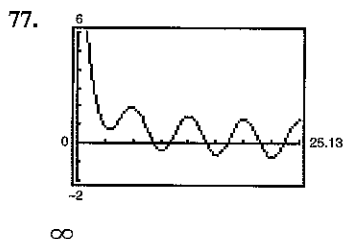
- (b)

$$y_3 = \frac{4}{\pi} \left[\sin(\pi x) + \frac{1}{3} \sin(3\pi x) + \frac{1}{5} \sin(5\pi x) + \frac{1}{7} \sin(7\pi x) \right]$$

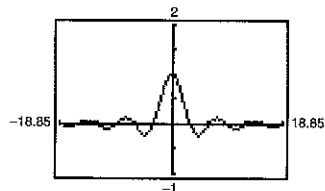


- (c)

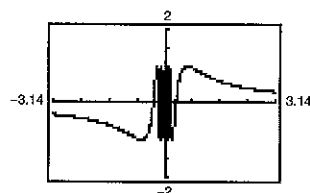
$$y_4 = \frac{4}{\pi} \left[\sin(\pi x) + \frac{1}{3} \sin(3\pi x) + \frac{1}{5} \sin(5\pi x) + \frac{1}{7} \sin(7\pi x) + \frac{1}{9} \sin(9\pi x) \right]$$



- 79.



- 81.



Oscillates

Section 1.7 (page 189)

Warm Up (page 189)

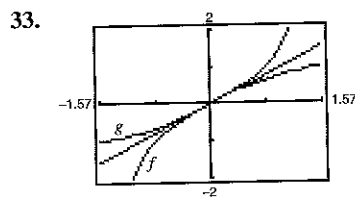
1. -1	2. -1	3. -1	4. $\frac{\sqrt{2}}{2}$	5. 0	6. $\frac{\pi}{6}$
7. π	8. $\frac{\pi}{4}$	9. 0	10. $-\frac{\pi}{4}$		

1. False. $\frac{5\pi}{6}$ is not in the range of the arcsine.
3. $\frac{\pi}{6}$ 5. $\frac{\pi}{3}$ 7. $\frac{\pi}{6}$ 9. $\frac{5\pi}{6}$ 11. $-\frac{\pi}{3}$ 13. $\frac{2\pi}{3}$
15. $\frac{\pi}{3}$ 17. 0 19. 1.29 21. -0.85 23. -1.25
25. 0.32 27. 1.99 29. 0.74 31. $-\frac{\pi}{3}, -\frac{1}{\sqrt{3}}, 1$

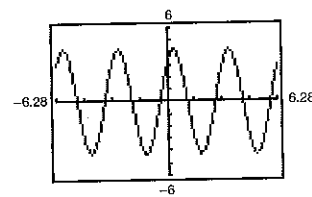
Name: _____ period: _____

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A81



79. $3\sqrt{2} \sin\left(2t + \frac{\pi}{4}\right)$

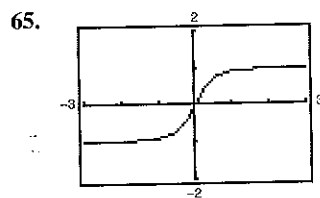


35. $\theta = \arctan \frac{x}{4}$ 37. $\theta = \arcsin \frac{x+2}{5}$ 39. 0.3

41. -0.1 43. 0 45. $\frac{3}{5}$ 47. $\frac{\sqrt{5}}{5}$ 49. $\frac{12}{13}$

51. $\frac{\sqrt{34}}{5}$ 53. $\frac{\sqrt{5}}{3}$ 55. $\frac{1}{x}$ 57. $\sqrt{1-4x^2}$

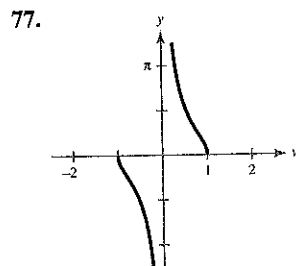
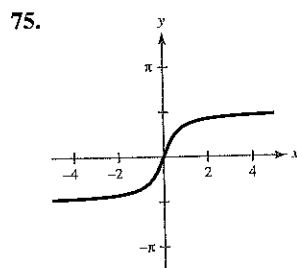
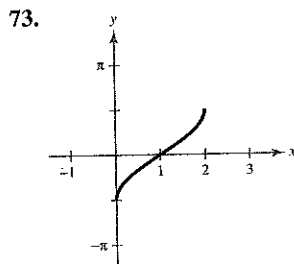
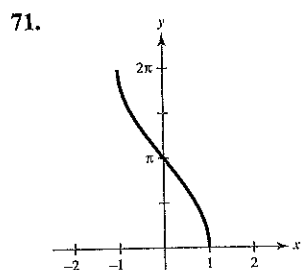
59. $\sqrt{1-x^2}$ 61. $\frac{\sqrt{9-x^2}}{x}$ 63. $\frac{\sqrt{x^2+2}}{x}$



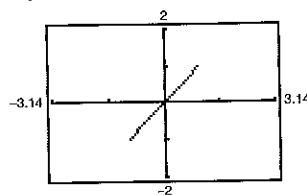
$y = \pm 1$

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

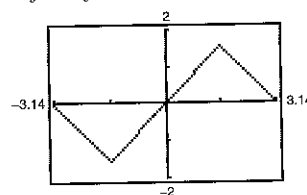
69. $\frac{|x-1|}{\sqrt{x^2-2x+10}}$



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

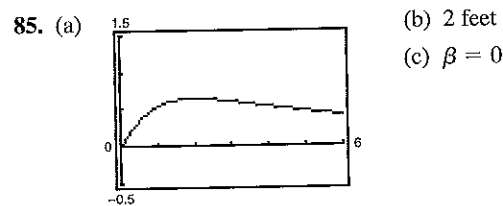


$f^{-1} \circ f$



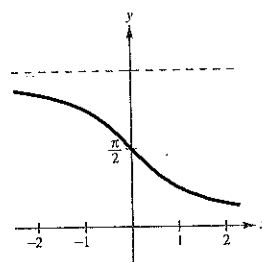
(b) The domain and range of the functions are restricted. The graphs of $f \circ f^{-1}$ and $f^{-1} \circ f$ differ because of the domains and ranges of f and f^{-1} .

83. (a) $\theta = \arcsin \frac{10}{s}$ (b) 0.21, 0.43



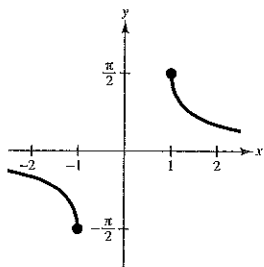
87. (a) $\theta = \arctan \frac{5}{x}$ (b) $26.6^\circ, 59.0^\circ$

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



91. Domain: $(-\infty, -1] \cup [1, \infty)$

Range: $[-\pi/2, 0) \cup (0, \pi/2]$



93–97. Answers will vary. 99. Buy now. 101. 8

Section 1.8 (page 200)

Warm Up (page 200)

1. 8.45	2. 78.99	3. 1.06	4. 1.24	5. 4.88
6. 34.14	7. 4; π	8. $\frac{1}{2}$; 2	9. 3; $\frac{2}{3}$	10. 0.2; 8π

1. $a \approx 3.64$ 3. $a \approx 8.26$ 5. $c \approx 11.66$

$c \approx 10.64$ $c \approx 25.38$ $A \approx 30.96^\circ$

$B = 70^\circ$ $A = 19^\circ$ $B \approx 59.04^\circ$

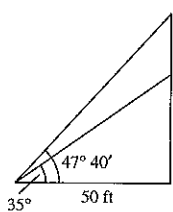
7. $a \approx 49.48$ 9. $a \approx 91.34$

$A \approx 72.08^\circ$ $b \approx 420.70$

$B = 17.92^\circ$ $B = 77^\circ 45'$

11. 2.56 inches 13. 103.9 feet 15. 15.4 feet

17. (a)



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

(c) 19.9 feet

19. 2236.8 feet 21. 56.3° 23. 15.5° 25. 5099 feet

27. 0.73 mile 29. 508 miles north; 650 miles east

31. (a) N 58° E (b) 68.82 meters 33. N 56.3° W

35. 1933.3 feet 37. ≈ 3.23 miles or $\approx 17,054$ feet

39. 78.7° 41. 35.3° 43. $y = \sqrt{3}r$ 45. 29.4 inches

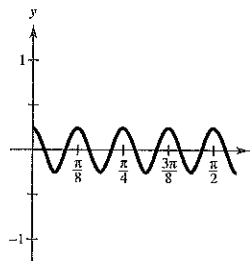
47. $a \approx 7$, $c \approx 12.2$ 49. (a) 4 (b) 4 (c) $\frac{1}{16}$

51. (a) $\frac{1}{16}$ (b) 60 (c) $\frac{1}{120}$ 53. $y = 4 \sin(\pi t)$

55. $y = 3 \cos\left(\frac{4\pi t}{3}\right)$

57. $\omega = 528\pi$

59. (a)



(b) $\frac{\pi}{8}$ seconds

(c) $\frac{\pi}{32}$ seconds

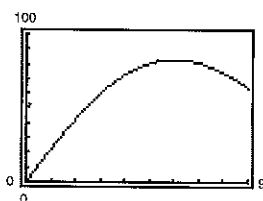
61. (a) and (b)

Base 1	Base 2	Altitude	Area
8	$8 + 16 \cos 10^\circ$	$8 \sin 10^\circ$	22.1
8	$8 + 16 \cos 20^\circ$	$8 \sin 20^\circ$	42.5
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

83.1 (maximum cross-sectional area)

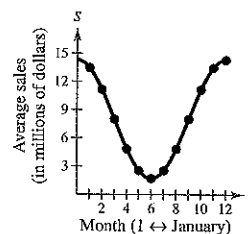
(c) $A = 64(1 + \cos \theta)(\sin \theta)$

(d)



83.1

63. (a)



(b) $S = 8 + 6.3 \cos\left(\frac{\pi t}{6}\right)$

(c) 12. Yes, sales of outerwear are seasonal.

(d) Maximum displacement from average sales of \$8 million

Name: _____ period: _____

1) Solve: $(2 + x)^2 = 64$

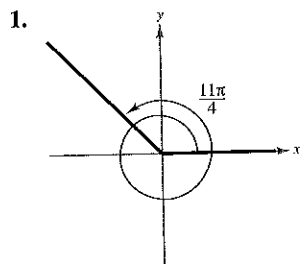
Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A83

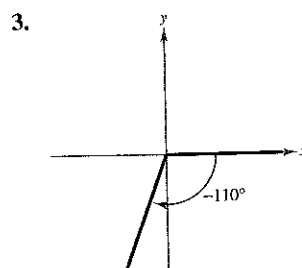
Focus on Concepts (page 206)

1. (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° .
2. Increases. The linear velocity is proportional to the radius.
3. False. For each θ there corresponds exactly one value of y .
4. Corresponding sides of similar triangles are proportional.
5. Undefined because $\sec \theta = 1/\cos \theta$.
6. Determine the trigonometric function of the reference angle and prefix the appropriate sign.
7. d ; the period is 2π and the amplitude is 3.
8. a ; the period is 2π and, because $a < 0$, the graph is reflected about the x -axis.
9. b ; the period is 2 and the amplitude is 2.
10. c ; the period is 4π and the amplitude is 2.
11. (a) Equal; two-period shift
 (b) Not equal; $f(t + \frac{1}{2}c)$ is a horizontal translation and $f(\frac{1}{2}t)$ is a period change.
 (c) Not equal; for example, $\sin[\frac{1}{2}(\pi + 2\pi)] \neq \sin(\frac{1}{2}\pi)$.
12. Their range is $(-\infty, \infty)$ or $(-\infty, -1] \cup [1, \infty)$.
13. (a) The displacement is increased.
 (b) The friction damps the oscillations more quickly.
 (c) The frequency of the oscillations increases.
14. False. $3\pi/4$ is not in the range of the arctangent function.

Review Exercises (page 207)



$$\frac{3\pi}{4}, \frac{5\pi}{4}$$



$$250^\circ, -470^\circ$$

5. 135.28° 7. 5.38° 9. $135^\circ 16' 12''$ 11. $-85^\circ 9'$
 13. 128.57° 15. -200.54° 17. 8.3776

19. -0.5890 21. 72° 23. $\frac{\pi}{5}$

25. $\sin \theta = -\frac{1}{2}$ 27. $\sin \theta = -\frac{\sqrt{3}}{2}$

$\cos \theta = -\frac{\sqrt{3}}{2}$ $\cos \theta = \frac{1}{2}$

$\tan \theta = \frac{1}{\sqrt{3}}$ $\tan \theta = -\sqrt{3}$

29. $\sin \theta = \frac{4}{5}$ 31. $\sin \theta = -\frac{\sqrt{11}}{6}$

$\cos \theta = \frac{3}{5}$ $\cos \theta = \frac{5}{6}$

$\tan \theta = \frac{4}{3}$ $\tan \theta = -\frac{\sqrt{11}}{5}$

$\csc \theta = \frac{5}{4}$ $\csc \theta = -\frac{6\sqrt{11}}{11}$

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

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

33. $\sqrt{3}$ 35. $-\frac{\sqrt{2}}{2}$ 37. 0.65 39. 3.24

41. $135^\circ = \frac{3\pi}{4}$, $225^\circ = \frac{5\pi}{4}$

43. $\approx 57^\circ$; ≈ 0.9949 ; $\approx 123^\circ$; ≈ 2.1467

45. $-\sqrt{3}$ 47. 135°

CHAPTER 2

Section 2.1 (page 219)

Warm Up (page 219)

1. $\sin \theta = \frac{3\sqrt{13}}{13}$

$\cos \theta = \frac{2\sqrt{13}}{13}$

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

$\csc \theta = \frac{\sqrt{13}}{3}$

$\sec \theta = \frac{\sqrt{13}}{2}$

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

3. $\sin \theta = -\frac{3\sqrt{58}}{58}$

$\cos \theta = \frac{7\sqrt{58}}{58}$

$\tan \theta = -\frac{3}{7}$

$\csc \theta = -\frac{\sqrt{58}}{3}$

$\sec \theta = \frac{\sqrt{58}}{7}$

$\cot \theta = -\frac{7}{3}$

5. $\frac{1}{2}$

6. $\frac{5}{4}$

7. $\frac{\sqrt{73}}{8}$

8. $\frac{2}{3}$

9. $\frac{x^2 + x + 16}{4(x + 1)}$

10. $\frac{8x - 2}{1 - x^2}$

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

$\cos \theta = \frac{1}{3}$

$\tan \theta = 2\sqrt{2}$

$\csc \theta = \frac{3\sqrt{2}}{4}$

$\sec \theta = 3$

$\cot \theta = \frac{\sqrt{2}}{4}$

4. $\sin \theta = \frac{\sqrt{5}}{5}$

$\cos \theta = -\frac{2\sqrt{5}}{5}$

$\tan \theta = -\frac{1}{2}$

$\csc \theta = \sqrt{5}$

$\sec \theta = -\frac{\sqrt{5}}{2}$

$\cot \theta = -2$

1. $\sin x = \frac{1}{2}$

$\cos x = \frac{\sqrt{3}}{2}$

$\tan x = \frac{\sqrt{3}}{3}$

$\csc x = 2$

$\sec x = \frac{2\sqrt{3}}{3}$

$\cot x = \sqrt{3}$

5. $\sin x = -\frac{5}{13}$

$\cos x = -\frac{12}{13}$

$\tan x = \frac{5}{12}$

$\csc x = -\frac{13}{5}$

$\sec x = -\frac{13}{12}$

$\cot x = \frac{12}{5}$

9. $\sin x = \frac{2}{3}$

$\cos x = -\frac{\sqrt{5}}{3}$

$\tan x = -\frac{2\sqrt{5}}{5}$

$\csc x = \frac{3}{2}$

$\sec x = -\frac{3\sqrt{5}}{5}$

$\cot x = -\frac{\sqrt{5}}{2}$

13. $\sin \theta = -1$

$\cos \theta = 0$

$\tan \theta$ is undefined.

$\csc \theta = -1$

$\sec \theta$ is undefined.

$\cot \theta = 0$

15. 1, 1 17. $\infty, 0$ 19. d 21. a 23. e

25. b 27. f 29. e 31. $\sec \phi$ 33. $\sin \beta$

35. $\cos x$ 37. 1 39. $-\tan x$ 41. $\tan x$

43. $1 + \sin y$ 45. $\sin^2 x$ 47. $\sin^2 x \tan^2 x$

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

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

$\tan \theta = -1$

$\csc \theta = -\sqrt{2}$

$\sec \theta = \sqrt{2}$

$\cot \theta = -1$

7. $\sin \phi = 0$

$\cos \phi = -1$

$\tan \phi = 0$

$\csc \phi$ is undefined.

$\sec \phi = -1$

$\cot \phi$ is undefined.

11. $\sin \theta = \frac{2\sqrt{5}}{5}$

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

$\tan \theta = 2$

$\csc \theta = -\frac{\sqrt{5}}{2}$

$\sec \theta = -\sqrt{5}$

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

Name: _____ period: _____

1) Solve: $(2 + x)^2 = 64$

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

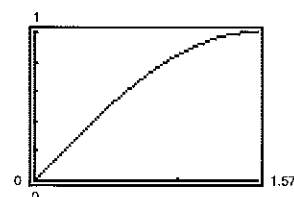
A87

49. $\sec^4 x$ 51. $\sin^2 x - \cos^2 x$ 53. $1 + 2 \sin x \cos x$
 55. $\tan^2 x$ 57. $2 \csc^2 x$ 59. $2 \sec x$ 61. $1 + \cos y$
 63. $3(\sec x + \tan x)$

65.

x	0.2	0.4	0.6	0.8	1.0
y_1	0.1987	0.3894	0.5646	0.7174	0.8415
y_2	0.1987	0.3894	0.5646	0.7174	0.8415

x	1.2	1.4
y_1	0.9320	0.9854
y_2	0.9320	0.9854

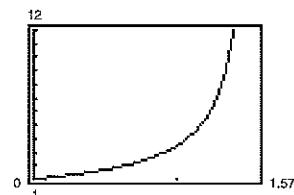


$y_1 = y_2$

67.

x	0.2	0.4	0.6	0.8	1.0
y_1	1.2230	1.5085	1.8958	2.4650	3.4082
y_2	1.2230	1.5085	1.8958	2.4650	3.4082

x	1.2	1.4
y_1	5.3319	11.6814
y_2	5.3319	11.6814



$y_1 = y_2$

69. $\csc x$ 71. $5 \cos \theta$ 73. $3 \tan \theta$ 75. $5 \sec \theta$

77. $0 \leq \theta \leq \pi$ 79. $0 \leq \theta < \frac{\pi}{2}, \frac{3\pi}{2} < \theta < 2\pi$

81. $\ln |\cot \theta|$ 83. Not an identity because $\frac{\sin k\theta}{\cos k\theta} = \tan k\theta$

85. Identity because $\sin \theta \cdot \frac{1}{\sin \theta} = 1$

87. (a) $\csc^2 132^\circ - \cot^2 132^\circ \approx 1.8107 - 0.8107 = 1$

(b) $\csc^2 \frac{2\pi}{7} - \cot^2 \frac{2\pi}{7} \approx 1.6360 - 0.6360 = 1$

89. (a) $\cos(90^\circ - 80^\circ) = \sin 80^\circ \approx 0.9848$

(b) $\cos\left(\frac{\pi}{2} - 0.8\right) = \sin 0.8 \approx 0.7174$

91. $\cos \theta = \pm \sqrt{1 - \sin^2 \theta}$

$\tan \theta = \pm \frac{\sin \theta}{\sqrt{1 - \sin^2 \theta}}$

$\csc \theta = \frac{1}{\sin \theta}$

$\sec \theta = \pm \frac{1}{\sqrt{1 - \sin^2 \theta}}$

$\cot \theta = \pm \frac{\sqrt{1 - \sin^2 \theta}}{\sin \theta}$

93. $x - 25$ 95. $4z + 12\sqrt{z} + 9$

Section 2.2 (page 227)

Warm Up (page 227)

1. (a) $x^2(1 + y)(1 - y)$ (b) $\sin^4 x$

2. (a) $x^2(1 + y^2)$ (b) 1

3. (a) $(x^2 + 1)(x + 1)(x - 1)$

(b) $\sec^2 x(\tan x + 1)(\tan x - 1)$

4. (a) $(z + 1)(z^2 - z + 1)$

(b) $(\tan x + 1)(\sec^2 x - \tan x)$ or

$(\tan x + 1)(\sec x - \sin x) \sec x$

5. (a) $(x - 1)(x^2 + 1)$ (b) $(\cot x - 1)\csc^2 x$

6. (a) $(x + 1)^2(x - 1)^2$ (b) $\cos^4 x$

7. (a) $\frac{y^2 - x^2}{x}$ (b) $\tan x$ 8. (a) $\frac{x^2 - 1}{x^2}$ (b) $\sin^2 x$

9. (a) $\frac{y^2 + (1 + z)^2}{y(1 + z)}$ (b) $2 \csc x$

10. (a) $\frac{y(1 + y) - z^2}{z(1 + y)}$ (b) $\frac{\tan x - 1}{\sec x(1 + \tan x)}$

1.-59. Answers will vary.

61. $\sin \theta = \pm \sqrt{1 - \cos^2 \theta}; \frac{7\pi}{4}$

63. $\sqrt{\tan^2 x} = |\tan x|; \frac{3\pi}{4}$ 65. 1 67. 2

69.-71. Answers will vary.

73. Seward; 6.4 and 1.9

Section 2.3 (page 237)

Warm Up (page 237)

1. $\frac{2\pi}{3}, \frac{4\pi}{3}$ 2. $\frac{\pi}{3}, \frac{2\pi}{3}$ 3. $\frac{\pi}{4}, \frac{7\pi}{4}$ 4. $\frac{7\pi}{4}, \frac{5\pi}{4}$

5. $\frac{\pi}{3}, \frac{4\pi}{3}$ 6. $\frac{3\pi}{4}, \frac{7\pi}{4}$ 7. $\frac{15}{8}$ 8. $-3, \frac{5}{2}$

9. $\frac{2 \pm \sqrt{14}}{2}$ 10. -1, 3

1. $x = -1, 3$ 3. $x = \pm 2$ 5.-9. Answers will vary.

11. $\frac{2\pi}{3} + 2n\pi, \frac{4\pi}{3} + 2n\pi$ 13. $\frac{\pi}{3} + 2n\pi, \frac{2\pi}{3} + 2n\pi$

15. $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi$

17. $\frac{\pi}{8} + n\pi, \frac{3\pi}{8} + n\pi, \frac{5\pi}{8} + n\pi, \frac{7\pi}{8} + n\pi$

19. $\frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$ 21. $\frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$

23. $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi, \frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$

25. $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$ 27. $0, \pi, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

29. $\frac{\pi}{3}, \frac{5\pi}{3}, \pi$ 31. No solution 33. $\frac{\pi}{2}$ 35. $\frac{\pi}{2}$

37. π 39. $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

41. $\frac{2}{3}, \frac{3}{2}; 0.8411 + 2n\pi, 5.4421 + 2n\pi$

43. 1.1071, 4.2487 45. 1.0472, 5.2360 47. 0, 1.8955

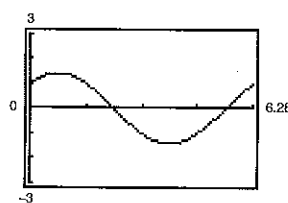
49. 0, 2.6779, 3.1416, 5.8195

51. 0.9828, 1.7682, 4.1244, 4.9098

53. 0.3398, 0.8481, 2.2935, 2.8018

55. 0.4271, 2.7145

57.



Maximum: $\left(\frac{\pi}{4}, \sqrt{2}\right)$

Minimum: $\left(\frac{5\pi}{4}, -\sqrt{2}\right)$

59. 1

61. (a) All real numbers except $x = 0$ (b) y-axis symmetry; horizontal asymptote: $y = 1$

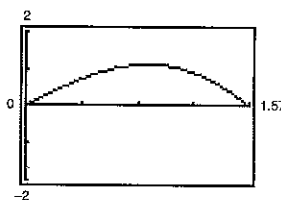
(c) Oscillates

(d) Infinitely many solutions

(e) Yes, 0.6366

63. 0.04, 0.43, 0.83 65. $37^\circ, 53^\circ$

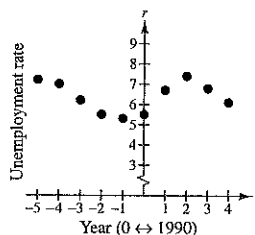
67. (a)



$x \approx 0.86, A \approx 1.12$

(b) $0.6 < x < 1.1$

69. (a)



(b) (3)

(c) Constant: 6.20%

(d) 7 years

(e) 2000

Name: _____ period: _____

Name: _____ period: _____

Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A89

Section 2.4 (page 246)

Warm Up (page 246)

1. $\frac{\sqrt{10}}{10}$	2. $\frac{-5\sqrt{34}}{34}$	3. $-\frac{\sqrt{7}}{4}$	4. $\frac{2\sqrt{2}}{3}$
5. $\frac{\pi}{4}, \frac{3\pi}{4}$	6. $\frac{\pi}{2}, \frac{3\pi}{2}$	7. $\tan^3 x$	8. $\cot^2 x$
9. $\sec x$	10. $1 - \tan^2 x$		

1. (a) $\frac{\sqrt{2} - \sqrt{6}}{4}$ (b) $\frac{\sqrt{2} + 1}{2}$

3. (a) $\frac{1}{2}$ (b) $\frac{-\sqrt{3} - 1}{2}$

5. False. Parts (a) and (b) are unequal in Exercises 1–4.

7. $\sin 75^\circ = \frac{\sqrt{2}}{4} (1 + \sqrt{3})$

$\cos 75^\circ = \frac{\sqrt{2}}{4} (\sqrt{3} - 1)$

$\tan 75^\circ = \sqrt{3} + 2$

9. $\sin 105^\circ = \frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\cos 105^\circ = \frac{\sqrt{2}}{4} (1 - \sqrt{3})$

$\tan 105^\circ = -2 - \sqrt{3}$

11. $\sin 195^\circ = \frac{\sqrt{2}}{4} (1 - \sqrt{3})$

$\cos 195^\circ = -\frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\tan 195^\circ = 2 - \sqrt{3}$

13. $\sin \frac{11\pi}{12} = \frac{\sqrt{2}}{4} (\sqrt{3} - 1)$

$\cos \frac{11\pi}{12} = -\frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\tan \frac{11\pi}{12} = -2 + \sqrt{3}$

15. $\sin \frac{17\pi}{12} = -\frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\cos \frac{17\pi}{12} = \frac{\sqrt{2}}{4} (1 - \sqrt{3})$

$\tan \frac{17\pi}{12} = 2 + \sqrt{3}$

17. $\sin 285^\circ = -\frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\cos 285^\circ = \frac{\sqrt{2}}{4} (\sqrt{3} - 1)$

$\tan 285^\circ = -(2 + \sqrt{3})$

19. $\sin \left(-\frac{13\pi}{12}\right) = \frac{\sqrt{2}}{4} (\sqrt{3} - 1)$

$\cos \left(-\frac{13\pi}{12}\right) = -\frac{\sqrt{2}}{4} (\sqrt{3} + 1)$

$\tan \left(-\frac{13\pi}{12}\right) = -2 + \sqrt{3}$

21. $\cos 40^\circ$ 23. $\sin 200^\circ$ 25. $\tan 239^\circ$ 27. $\sin 1.8$

29. $\tan 3x$ 31. $-\frac{63}{65}$ 33. $\frac{16}{65}$ 35. $\frac{65}{16}$

37. $\frac{33}{56}$ 39. $\frac{3}{5}$ 41. $\frac{44}{125}$ 43. $\frac{5}{4}$

45.–61. Answers will vary.

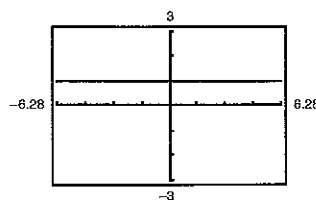
63. (a) $\sqrt{2} \sin \left(\theta + \frac{\pi}{4}\right)$ (b) $\sqrt{2} \cos \left(\theta - \frac{\pi}{4}\right)$

65. (a) $13 \sin(3\theta + 0.3948)$ (b) $13 \cos(3\theta - 1.1760)$

67. $2 \cos \theta$ 69. 1 71. $\frac{\pi}{2}$ 73. $\frac{5\pi}{4}, \frac{7\pi}{4}$

75. $\frac{\pi}{4}, \frac{7\pi}{4}$

77.



$\sin^2 \left(\theta + \frac{\pi}{4}\right) + \sin^2 \left(\theta - \frac{\pi}{4}\right) = 1$

79. (a) $y = \frac{5}{12} \sin(2t + 0.6435)$

(b) $\frac{5}{12}$ foot (c) $\frac{1}{\pi}$ cycle per second

Section 2.5 (page 257)

Warm Up (page 257)

1. $\sin x(2 + \cos x)$	2. $(\cos x - 2)(\cos x + 1)$
3. $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$	4. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$
5. π	6. 0
7. $\frac{2 - \sqrt{2}}{4}$	8. $\frac{3}{4}$
9. $\tan 3x$	10. $\frac{1}{2} \csc^2 x - 1$

1. $\frac{3}{5}$ 3. $\frac{7}{25}$ 5. $\frac{24}{7}$ 7. $\frac{25}{24}$ 9. $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}$

11. $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$ 13. $0, \frac{2\pi}{3}, \frac{4\pi}{3}$

15. $\frac{\pi}{2}, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{3\pi}{2}, \frac{11\pi}{6}$ 17. $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$

19. $3 \sin 2x$ 21. $4 \cos 2x$

23. $\sin 2u = \frac{24}{25}$ 25. $\sin 2u = \frac{4}{5}$
 $\cos 2u = \frac{7}{25}$ $\cos 2u = \frac{3}{5}$
 $\tan 2u = \frac{24}{7}$ $\tan 2u = \frac{4}{3}$

27. $\sin 2u = -\frac{4\sqrt{21}}{25}$

$\cos 2u = -\frac{17}{25}$

$\tan 2u = \frac{4\sqrt{21}}{17}$

29. $\frac{1}{8}(3 + 4 \cos 2x + \cos 4x)$ 31. $\frac{1}{8}(1 - \cos 4x)$

33. $\frac{1}{32}(2 + \cos 2x - 2 \cos 4x - \cos 6x)$

35. $\frac{5}{\sqrt{26}}$ 37. $\frac{1}{5}$ 39. $\sqrt{26}$

41. $\sin 105^\circ = \frac{1}{2}\sqrt{2 + \sqrt{3}}$

$\cos 105^\circ = -\frac{1}{2}\sqrt{2 - \sqrt{3}}$

$\tan 105^\circ = -2 - \sqrt{3}$

43. $\sin 112^\circ 30' = \frac{1}{2}\sqrt{2 + \sqrt{2}}$

$\cos 112^\circ 30' = -\frac{1}{2}\sqrt{2 - \sqrt{2}}$

$\tan 112^\circ 30' = -1 - \sqrt{2}$

45. $\sin \frac{\pi}{8} = \frac{1}{2}\sqrt{2 - \sqrt{2}}$

$\cos \frac{\pi}{8} = \frac{1}{2}\sqrt{2 + \sqrt{2}}$

$\tan \frac{\pi}{8} = \sqrt{2} - 1$

49. $\sin \frac{u}{2} = \sqrt{\frac{89 - 8\sqrt{89}}{178}}$

$\cos \frac{u}{2} = -\sqrt{\frac{89 + 8\sqrt{89}}{178}}$

$\tan \frac{u}{2} = \frac{8 - \sqrt{89}}{5}$

47. $\sin \frac{u}{2} = \frac{5\sqrt{26}}{26}$

$\cos \frac{u}{2} = \frac{\sqrt{26}}{26}$

$\tan \frac{u}{2} = 5$

51. $\sin \frac{u}{2} = \frac{3\sqrt{10}}{10}$

$\cos \frac{u}{2} = -\frac{\sqrt{10}}{10}$

$\tan \frac{u}{2} = -3$

53. $|\sin 3x|$ 55. $-|\tan 4x|$ 57. π

59. $\frac{\pi}{3}, \pi, \frac{5\pi}{3}$ 61. $3\left(\sin \frac{\pi}{2} + \sin 0\right)$

63. $\frac{1}{2}(\sin 8\theta + \sin 2\theta)$ 65. $\frac{5}{2}(\cos 8\beta + \cos 2\beta)$

67. $\frac{1}{2}(\cos 2y - \cos 2x)$ 69. $\frac{1}{2}(\sin 2\theta + \sin 2\pi)$

71. $2 \sin 45^\circ \cos 15^\circ$ 73. $-2 \sin \frac{\pi}{2} \sin \frac{\pi}{4}$

75. $2 \cos 4x \cos 2x$ 77. $2 \cos \alpha \sin \beta$

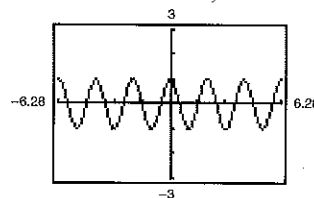
79. $2 \cos(\phi + \pi) \cos \pi$

81. $0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi, \frac{5\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4}$

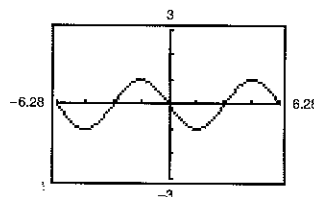
83. $\frac{\pi}{6}, \frac{5\pi}{6}$ 85. $\frac{25}{169}$ 87. $\frac{4}{13}$

89.–101. Answers will vary.

103.



105.

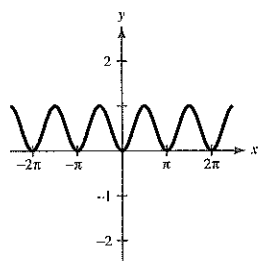


1) Solve: $(2+x)^2 = 64$

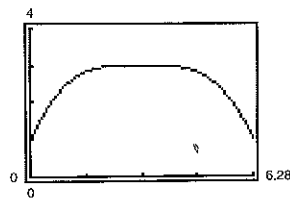
Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A91

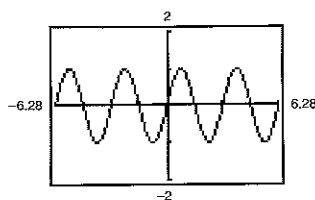
107.



109.

Maximum: $(\pi, 3)$

111. (a)



(b) $g(x) = \sin 2x$

(c) Answers will vary.

113. $2x\sqrt{1-x^2}$

115. (a) $A = 100 \sin \frac{\theta}{2} \cos \frac{\theta}{2}$

(b) $A = 50 \sin \theta$

The area is maximum when $\theta = \frac{\pi}{2}$.

117. September: \$235,000 119. 15.7 gallons

October: \$272,600

Focus on Concepts (page 261)

1. An identity is true for all values of the variable and a conditional equation is true for some values of the variable.
2. When proving an identity you use the fundamental identities and rules of algebra to transform one expression into another. To solve a trigonometric equation, use standard algebraic techniques and identities to isolate a trigonometric function involved in the equation. Find the value of the variable by using the inverse of the trigonometric function.

3. Reciprocal identities: $\csc \theta = \frac{1}{\sin \theta}$, $\sec \theta = \frac{1}{\cos \theta}$

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

Quotient identities: $\tan \theta = \frac{\sin \theta}{\cos \theta}$, $\cot \theta = \frac{\cos \theta}{\sin \theta}$

Pythagorean identities: $\sin^2 \theta + \cos^2 \theta = 1$,

$\tan^2 \theta + 1 = \sec^2 \theta$, $1 + \cot^2 \theta = \csc^2 \theta$

4. No. $\cos \theta = \pm \sqrt{1 - \sin^2 \theta}$

5. False. The order in which algebraic operations and fundamental identities are done may vary.

6. (a) True. The period of tangent is π .(b) False. The period of cosine is 2π .(c) False. $\sec \theta \cos \theta = 1$

(d) True.

(e) True. $\sin(-\alpha) = -\sin \alpha$

7. $y_1 = y_2 + 1$ 8. $y_1 = 1 - y_2$ 9. 1 10. 3

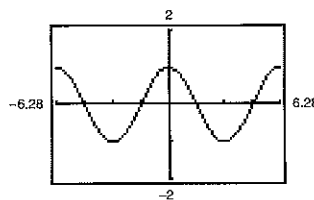
11. 5 12. 4 13. 2π

Review Exercises (page 262)

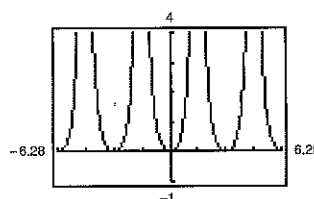
1. $\sin^2 x$ 3. $1 + \cot \alpha$ 5. 1 7. $\tan(2x + 2)$

9.-25. Answers will vary.

27.



29.



31. $\frac{\sqrt{2}}{4}(\sqrt{3} + 1)$ 33. $-\frac{1}{2}\sqrt{2 + \sqrt{2}}$

35. $-\frac{3}{52}(5 + 4\sqrt{7})$ 37. $\frac{1}{52}(36 + 5\sqrt{7})$

39. $\frac{1}{4}\sqrt{2(4 - \sqrt{7})}$

41. False. If $\frac{\pi}{2} < \theta < \pi$, then $\cos \frac{\theta}{2} > 0$.

43. True 45. 0, π 47. 0, $\frac{3\pi}{4}$, π , $\frac{5\pi}{4}$

49. 0, $\frac{\pi}{2}$, π 51. $\frac{\pi}{3}$, $\frac{5\pi}{3}$ 53. $\frac{\pi}{4}$, $\frac{5\pi}{4}$

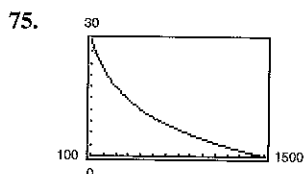
55. False. $\sin \theta = \frac{1}{2}$ has an infinite number of solutions but is not an identity.

A110 Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

73.

r	0.005	0.010	0.015
t	138.6 yr	69.3 yr	46.2 yr

r	0.020	0.025	0.030
t	34.7 yr	27.7 yr	23.1 yr



17.66 cubic feet per minute

77. 21,357 foot-pounds 79. 30 years

81. Total amount: \$473,886

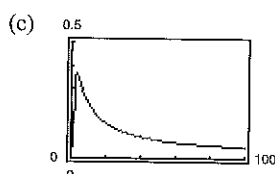
Interest: \$323,886

83. (a)

x	1	5	10	10^2
$f(x)$	0	0.322	0.230	0.046

x	10^4	10^6
$f(x)$	0.00092	0.0000138

(b) 0

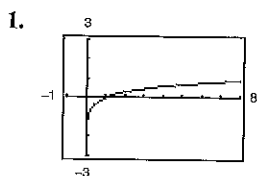


85. $8n - 3$ 87. $83.95 + 37.50t$

Section 5.3 (page 383)

Warm Up (page 383)

1. 2	2. -5	3. -2	4. -3	5. e^5
6. $\frac{1}{e}$	7. e^6	8. 1	9. x^{-2}	10. $x^{1/2}$



3. $\frac{\log_{10} 5}{\log_{10} 3}$ 5. $\frac{\log_{10} x}{\log_{10} 2}$ 7. $\frac{\ln 5}{\ln 3}$ 9. $\frac{\ln x}{\ln 2}$ 11. 1.771

13. -2.000 15. -0.417 17. 2.633

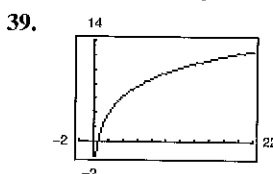
19. $\log_{10} 5 + \log_{10} x$ 21. $\log_{10} 5 - \log_{10} x$ 23. $4 \log_8 x$

25. $\frac{1}{2} \ln z$ 27. $\ln x + \ln y + \ln z$ 29. $\frac{1}{2} \ln(a - 1)$

31. $\ln z + 2 \ln(z - 1)$ 33. $\frac{1}{3} \ln x - \frac{1}{3} \ln y$

35. $4 \ln x + \frac{1}{2} \ln y - 5 \ln z$

37. $2 \log_b x - 2 \log_b y - 3 \log_b z$

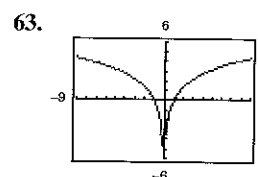
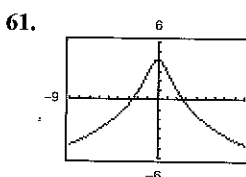


41. $\ln 2x$ 43. $\log_4 \frac{z}{y}$ 45. $\log_2(x + 4)^2$

47. $\log_3 \sqrt[3]{5x}$ 49. $\ln \frac{x}{(x+1)^3}$ 51. $\ln \frac{x-2}{x+2}$

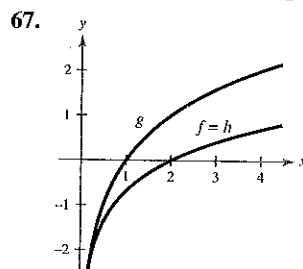
53. $\ln \frac{x}{(x^2 - 4)^2}$ 55. $\ln \sqrt[3]{\frac{x(x+3)^2}{x^2 - 1}}$

57. $\ln \frac{\sqrt[3]{y(y+4)^2}}{y-1}$ 59. $\ln \frac{9}{\sqrt{x^2 + 1}}$



No. The domains differ.

65. $\log_2 \frac{32}{4} = \log_2 32 - \log_2 4$



$f(x) = h(x)$

69. 2 71. 2.4 73. -9 is not in the domain of $\log_3 x$.

75. 2 77. -3 79. 0 is not in the domain of $\log_{10} x$.

81. 4.5 83. $\frac{3}{2}$ 85. $-3 - \log_5 2$ 87. $6 + \ln 5$

Name: _____ period: _____

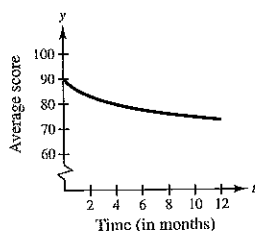
Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

A111

89. (a) 90 (b) 77 (c) 73 (d) 9 months

(e) $90 - \log_{10}(t + 1)^{15}$

(f)



91. False. $\ln 1 = 0$ 93. False. $\ln(x - 2) \neq \ln x - \ln 2$

95. False. $u = v^2$ 97. Answers will vary.

99. $\frac{3x^4}{2y^3}, x \neq 0$ 101. 1

Section 5.4 (page 393)

Warm Up (page 393)

- | | | | | |
|--------------------------|--------------------------|------------------|---------|--------------|
| 1. $\frac{\ln 3}{\ln 2}$ | 2. $1 + \frac{2}{\ln 4}$ | 3. $\frac{e}{2}$ | 4. $2e$ | 5. $2 \pm i$ |
| 6. $\frac{1}{2}, 1$ | 7. $2x$ | 8. $3x$ | 9. $2x$ | 10. $-x^2$ |

1. (a) Yes (b) No 3. (a) No (b) Yes (c) Yes

5. (a) No (b) No (c) Yes 7. (3, 8) 9. (9, 2)

11. 2 13. -2 15. 3 17. 64 19. $\frac{1}{10}$

21. x^2 23. $5x + 2$ 25. x^2 27. $\ln 10 \approx 2.303$

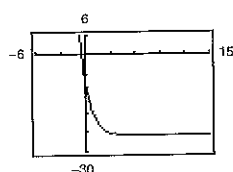
29. 0 31. $\frac{\ln 12}{3} \approx 0.828$ 33. $\ln \frac{5}{3} \approx 0.511$

35. $\ln 5 \approx 1.609$ 37. $2 \ln 75 \approx 8.635$

39. $\log_{10} 42 \approx 1.623$ 41. $\frac{\ln 80}{2 \ln 3} \approx 1.994$

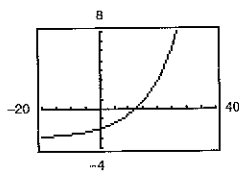
43. 2 45. $\frac{\ln 8 - \ln 565}{\ln 2} \approx -6.142$

47.



-0.427

49.



12.207

51. 0.059 53. 21.330 55. $e^{-3} \approx 0.050$

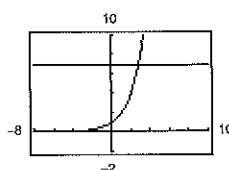
57. $\frac{e^{2.4}}{2} \approx 5.512$ 59. $e^2 - 2 \approx 5.389$ 61. 103

63. $1 + \sqrt{1 + e} \approx 2.928$ 65. $\frac{-1 + \sqrt{17}}{2} \approx 1.562$

67. 4 69. No solution 71. 14.988

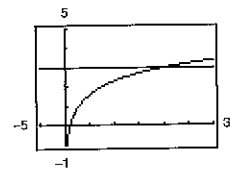
73. 33.115 75. 14.369

77.



(2.807, 7)

79.



(20.086, 3)

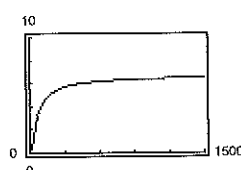
81. 8.2 years

83. Yes. Time to double: $t = \frac{\ln 2}{r}$

Time to quadruple: $t = \frac{\ln 4}{r} = 2 \left(\frac{\ln 2}{r} \right)$

85. 12.9 years 87. (a) 1426 units (b) 1498 units

89. (a)



(b) $y = 6.7$. Yield will approach 6.7 million cubic feet per acre.

(c) 29.3 years

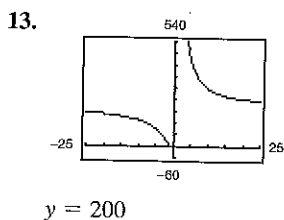
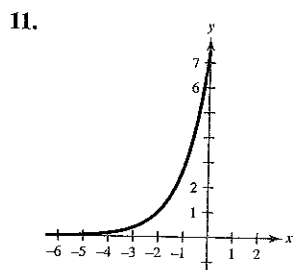
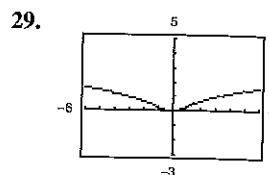
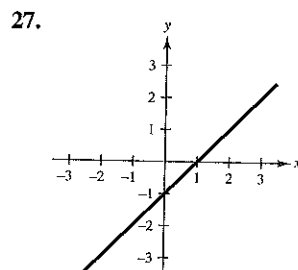
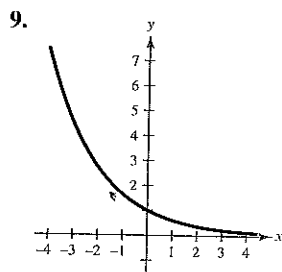
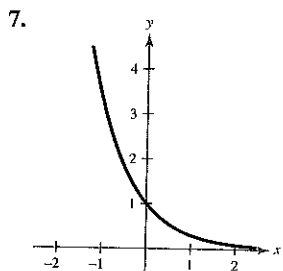
91. (a) $y = 100$ and $y = 0$; the range falls between 0% and 100%

(b) Males: 69.71 inches Females: 64.51 inches

93. (a) $y = 20$; Room temperature (b) 0.81 hour

95. $4|x|y^2\sqrt{3y}$ 97. $5\sqrt[3]{3}$

A114 Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests



15.

n	1	2	4	12
A	\$9499.28	\$9738.91	\$9867.22	\$9956.20

n	365	Continuous
A	\$10,000.27	\$10,001.78

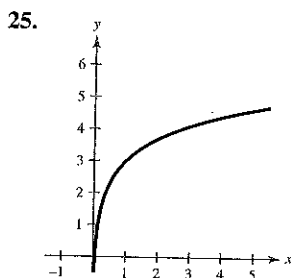
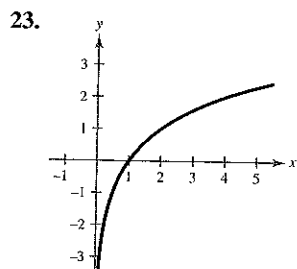
17.

t	1	10	20
P	\$184,623.27	\$89,865.79	\$40,379.30

t	30	40	50
P	\$18,143.59	\$8152.44	\$3663.13

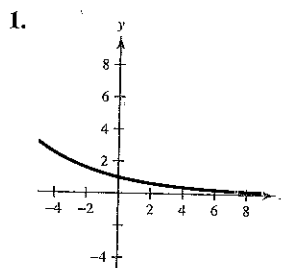
19. (a) 0.154 (b) 0.487 (c) 0.811

21. (a) \$1,069,047.14 (b) 7.9 years

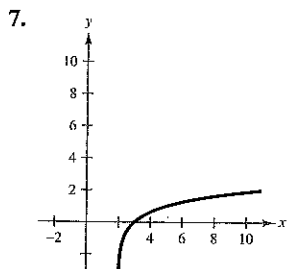


31. $\log_4 64 = 3$ 33. 3 35. 7 37. 1.585
 39. 2.132 41. $1 + 2\log_5 |x|$
 43. $\log_{10} 5 + \frac{1}{2} \log_{10} y - 2 \log_{10} |x|$ 45. $\log_2 5x$
 47. $\ln \frac{\sqrt{2x-1}}{(x+1)^2}$ 49. True 51. False 53. True
 55. 27.16 miles 57. $\ln 12 \approx 2.485$
 59. $-\frac{\ln 44}{5} \approx -0.757$ 61. $\ln 2 \approx 0.693$, $\ln 5 \approx 1.609$
 63. $\frac{1}{3}e^{8.2} \approx 1213.650$ 65. $3e^2 \approx 22.167$
 67. No solution 69. 0.39, 7.48 71. 1.64
 73. $y = 2e^{0.1014x}$ 75. (a) 1151 units (b) 1325 units
 77. (a) 13.86% (b) \$11,486.65
 79. (a) $10^{8.4}$ (b) $10^{6.85}$ (c) $10^{9.1}$

Chapter Test (page 416)



2. $y = 1000$
 3. (a) \$34,596.89 (b) \$35,143.44
 4. \$40,386.38 5. $4^3 = 64$ 6. $\log_5 \frac{1}{25} = -2$



8. $\ln 6 + 2 \ln x - \frac{1}{2} \ln(x^2 + 1)$ 9. $\ln \frac{z^3}{z^2 - 1}$
10. $1 + \frac{1}{2} \log_6 10$ 11. 12.218 12. 18.447
13. 77.451 14. \$10,204 15. 300 16. 570
17. 9 years 18. c

CHAPTER 6

Section 6.1 (page 423)

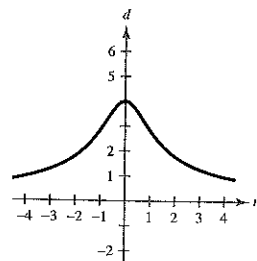
Warm Up (page 423)

1. $\sqrt{106}$ 2. $2\sqrt{13}$ 3. 1 4. $\frac{6}{7}$ 5. $-\frac{3}{2}$
6. $-\frac{1}{2}$ 7. $2x - 3y + 9 = 0$ 8. $7x - 2y - 24 = 0$
9. $4x + y - 32 = 0$ 10. $3x + 4y + 2 = 0$

1. $\frac{\sqrt{3}}{3}$ 3. -1 5. 0.7869 7. -2.7475
9. 135° 11. 36.9° 13. 60.3° 15. 121.0°
17. 78.7° 19. 121.0° 21. 0.1139, 1195 feet
23. (a) 18.4° (b) 15.8 meters 25. 71.6°
27. 11.3° 29. 81.9° 31. 53.1° 33. 46.9°
35. (2, 1), 42.3° ; (4, 4), 78.7° ; (6, 2), 59.0°
37. (-4, -1), 11.9° ; (3, 2), 21.8° ; (1, 0), 146.3°
39. (a) 69° (b) 5970 feet, 2415 feet 41. 0 43. 1.4
45. 7 47. $\frac{8\sqrt{37}}{37} \approx 1.3152$ 49. (a) $\frac{7\sqrt{10}}{5}$ (b) 7
51. (a) $\frac{35\sqrt{37}}{74}$ (b) $\frac{35}{8}$ 53. $2\sqrt{2}$

55. (a) $d = \frac{4}{\sqrt{m^2 + 1}}$

(b)



- (c) $m = 0$
- (d) $d = 0$. As the line approaches the vertical, the distance approaches 0.

Section 6.2 (page 431)

Warm Up (page 431)

1. $x^2 - 10x + 5$ 2. $x^2 + 6x + 8$
3. $-x^2 - 8x - 6$ 4. $-x^2 + 4x$ 5. $(x + 3)^2 - 1$
6. $(x - 5)^2 - 4$ 7. $2 - (x - 1)^2$ 8. $-2(x - 1)^2$
9. $2x + 3y - 20 = 0$ 10. $3x - 4y - 17 = 0$

1. e 3. d 5. a

7. Vertex: (0, 0)

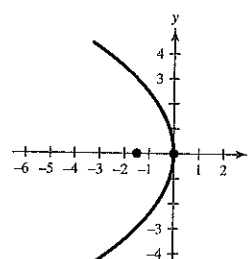
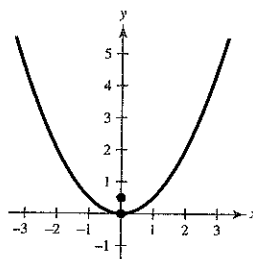
Focus: $(0, \frac{1}{2})$

Directrix: $y = -\frac{1}{2}$

9. Vertex: (0, 0)

Focus: $(-\frac{3}{2}, 0)$

Directrix: $x = \frac{3}{2}$



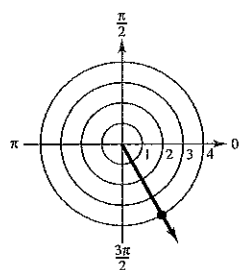
Section 6.7 (page 479)

Warm Up (page 479)

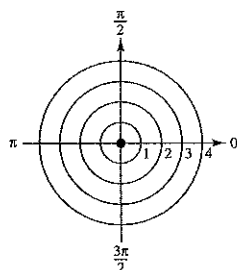
1. $\frac{3\pi}{4}$	2. $\frac{7\pi}{6}$	3. $\sin \theta = \frac{\sqrt{5}}{5}; \cos \theta = \frac{2\sqrt{5}}{5}$
4. $\sin \theta = -\frac{3}{5}; \cos \theta = \frac{4}{5}$	5. $\frac{3\pi}{4}$	6. 0.5880
7. $-\frac{\sqrt{3}}{2}$	8. $-\frac{\sqrt{2}}{2}$	9. -0.3090 10. 0.9735

1. (0, 4) 3. $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

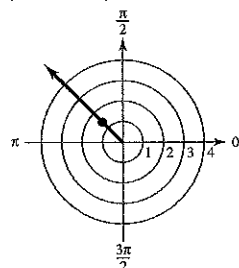
5.



7.

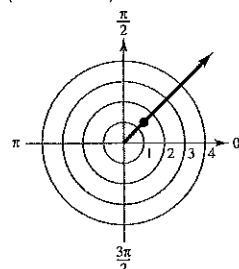


9. $(2, -2\sqrt{3})$



11. $(-\sqrt{2}, \sqrt{2})$

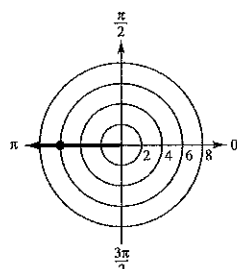
15.



$\left(\sqrt{2}, \frac{\pi}{4}\right), \left(-\sqrt{2}, \frac{5\pi}{4}\right)$

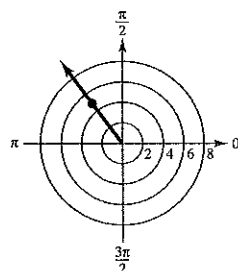
13. $(-1.204, -4.336)$

17.



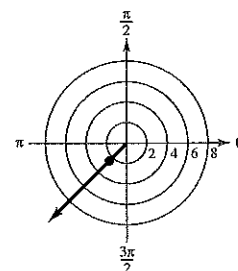
$(6, \pi), (-6, 0)$

19.



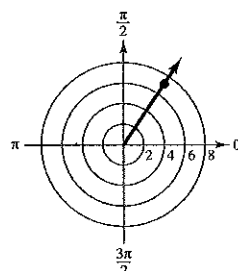
$(5, 2.214), (-5, 5.356)$

21.



$\left(\sqrt{6}, \frac{5\pi}{4}\right), \left(-\sqrt{6}, \frac{\pi}{4}\right)$

23.



$(2\sqrt{13}, 0.983), (-2\sqrt{13}, 4.124)$

25. $(\sqrt{13}, -0.588)$ 27. $(\sqrt{7}, 0.857)$ 29. $\left(\frac{17}{6}, 0.490\right)$

31. True 33. $r = 3$ 35. $r = 2a \cos \theta$

37. $r = 4 \csc \theta$ 39. $r = 10 \sec \theta$

41. $r = \frac{-2}{3 \cos \theta - \sin \theta}$

43. $r^2 = 4 \sec \theta \csc \theta = 8 \csc 2\theta$ 45. $r^2 = 9 \cos 2\theta$

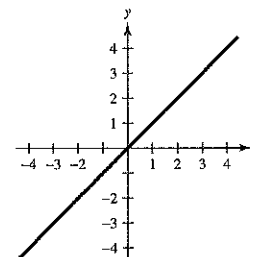
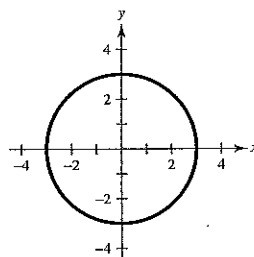
47. $x^2 + y^2 - 4y = 0$ 49. $\sqrt{3}x - 3y = 0$

51. $y = 2$ 53. $(x^2 + y^2)^2 = 6x^2y - 2y^3$

55. $4x^2 - 5y^2 - 36y - 36 = 0$

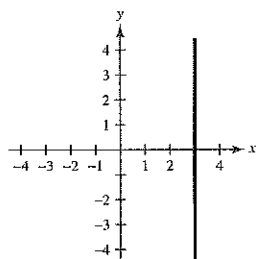
57. $x^2 + y^2 = 9$

59. $x - y = 0$



A126 Answers to Warm Ups, Odd-Numbered Exercises, Focus on Concepts, and Tests

61. $x - 3 = 0$



63. $(x - h)^2 + (y - k)^2 = h^2 + k^2$

Center: (h, k)

Radius: $\sqrt{h^2 + k^2}$

65. (a) Answers will vary.

(b) $d = \sqrt{r_1^2 + r_2^2 - 2r_1r_2} = |r_1 - r_2|$

The distance between two points on the line
 $\theta = \theta_1 = \theta_2$.

(c) $d = \sqrt{r_1^2 + r_2^2}$

Pythagorean Theorem

(d) Points: $(3, \pi/6)$, $(4, \pi/3)$

Distance: 2.053

Points: $(-3, 7\pi/6)$, $(-4, 4\pi/3)$

Distance: 2.053

67. $(2, 3)$ 69. $(\frac{8}{7}, \frac{88}{35}, \frac{8}{5})$ 71. $(1, -4, 1, 2)$

Section 6.8 (page 488)

Warm Up (page 488)

1. Amplitude: 5 2. Amplitude: 3 3. Amplitude: 5

Period: $\frac{\pi}{2}$

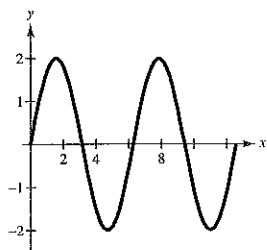
Period: 1

Period: $\frac{4}{5}$

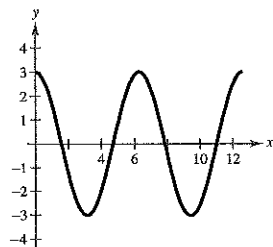
4. Amplitude: $\frac{1}{2}$

Period: 4π

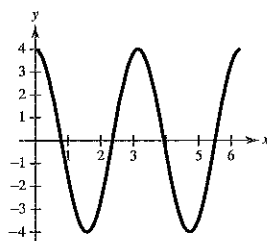
5.



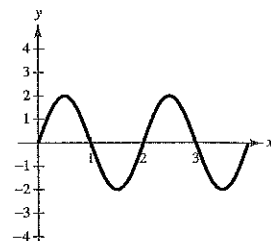
6.



7.



8.



9. $\frac{1}{2}(\sqrt{3} \sin x - \cos x)$ 10. $\frac{\sqrt{2}}{2}(\cos x + \sin x)$

1. Rose curve 3. Limaçon 5. Rose curve

7. Polar axis 9. $\theta = \frac{\pi}{2}$ 11. $\theta = \frac{\pi}{2}$, polar axis, pole

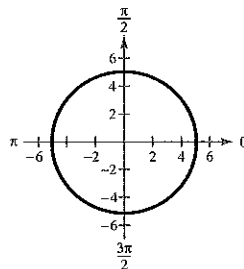
13. Maximum: $|r| = 20$ when $\theta = \frac{3\pi}{2}$

Zero: $r = 0$ when $\theta = \frac{\pi}{2}$

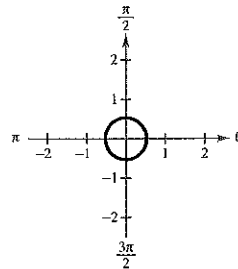
15. Maximum: $|r| = 4$ when $\theta = 0, \frac{\pi}{3}, \frac{2\pi}{3}$

Zero: $r = 0$ when $\theta = \frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}$

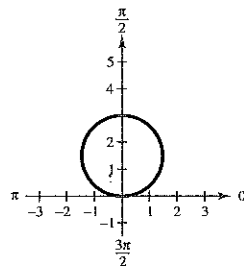
17.



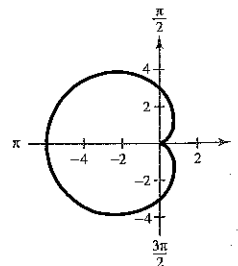
19.



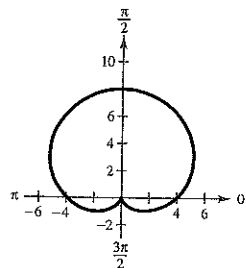
21.



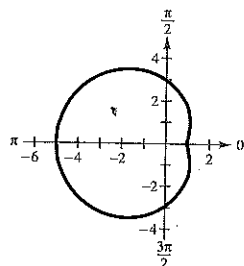
23.



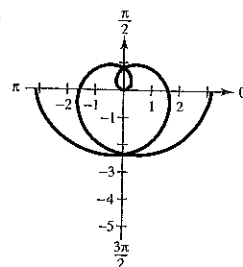
25.



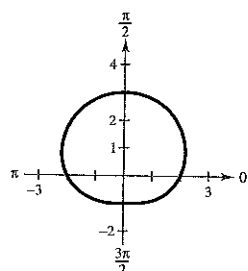
27.



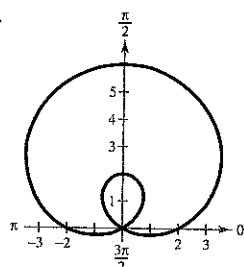
45.



29.

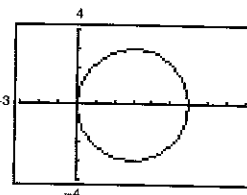


31.

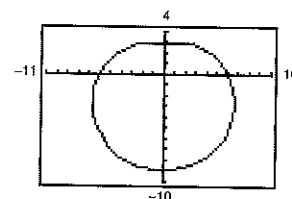


$$-2\pi \leq \theta \leq 2\pi$$

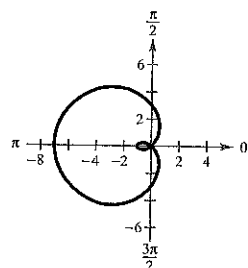
47.



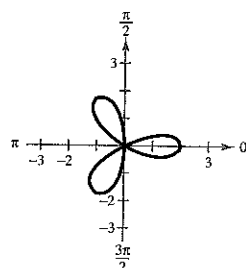
49.



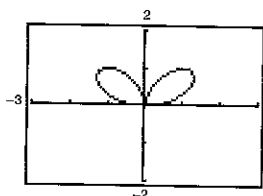
33.



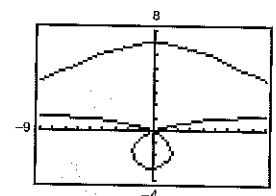
35.



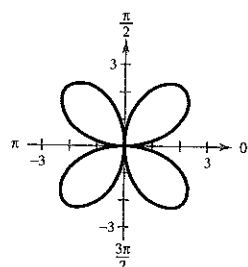
51.



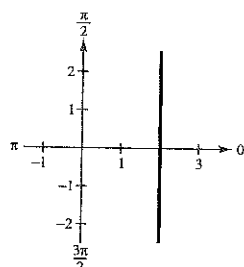
53.



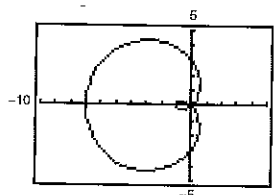
37.



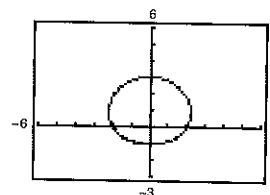
39.



55.



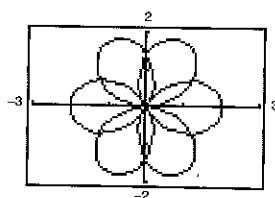
57.



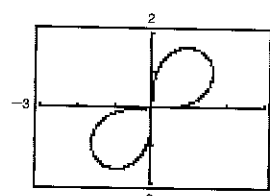
$$0 \leq \theta < 2\pi$$

$$0 \leq \theta < 2\pi$$

59.



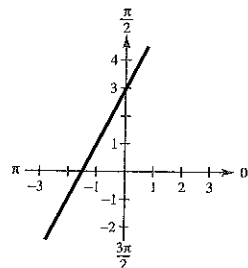
61.



$$0 \leq \theta < 4\pi$$

$$0 \leq \theta < \pi$$

41.



43.

