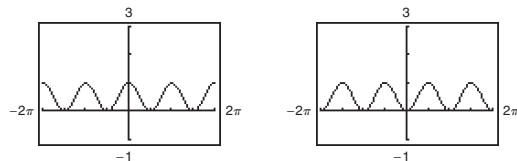


3. (a) 4767 feet (b) 3705 feet  
(c)  $w = 2183$  feet,

$$\tan 63^\circ = \frac{w + 3705}{3000}$$

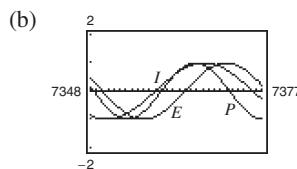
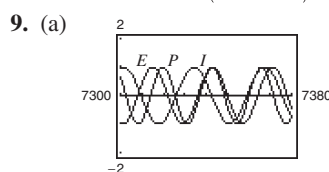
5. (a) (b)



Even

Even

7.  $h = 51 - 50 \sin\left(8\pi t + \frac{\pi}{2}\right)$



- (c)  $P(7369) = 0.631$   
 $E(7369) = 0.901$   
 $I(7369) = 0.945$

11. (a) 3.35, 7.35 (b)  $-0.65$   
(c) Yes. There is a difference of nine periods between the values.  
13. (a)  $40.5^\circ$  (b)  $x \approx 1.71$  feet;  $y \approx 3.46$  feet  
(c)  $\approx 1.75$  feet  
(d) As you move closer to the rock,  $d$  must get smaller and smaller. The angles  $\theta_1$  and  $\theta_2$  will decrease along with the distance  $y$ , so  $d$  will decrease.

## Chapter 5

### Section 5.1 (page 379)

#### Vocabulary Check (page 379)

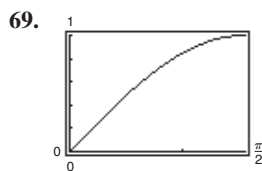
1.  $\tan u$    2.  $\cos u$    3.  $\cot u$    4.  $\csc u$   
5.  $\cot^2 u$    6.  $\sec^2 u$    7.  $\cos u$    8.  $\csc u$   
9.  $\cos u$    10.  $-\tan u$

### Answers to Odd-Numbered Exercises and Tests

A147

1.  $\sin x = \frac{\sqrt{3}}{2}$   
 $\cos x = -\frac{1}{2}$   
 $\tan x = -\sqrt{3}$   
 $\csc x = \frac{2\sqrt{3}}{3}$   
 $\sec x = -2$   
 $\cot x = -\frac{\sqrt{3}}{3}$
3.  $\sin \theta = -\frac{\sqrt{2}}{2}$   
 $\cos \theta = \frac{\sqrt{2}}{2}$   
 $\tan \theta = -1$   
 $\sec \theta = \sqrt{2}$   
 $\csc \theta = -\sqrt{2}$   
 $\cot \theta = -1$
5.  $\sin x = -\frac{5}{13}$   
 $\cos x = -\frac{12}{13}$   
 $\tan x = \frac{5}{12}$   
 $\sec x = -\frac{13}{12}$   
 $\csc x = -\frac{13}{5}$   
 $\cot x = \frac{12}{5}$
7.  $\sin \phi = -\frac{\sqrt{5}}{3}$   
 $\cos \phi = \frac{2}{3}$   
 $\tan \phi = -\frac{\sqrt{5}}{2}$   
 $\sec \phi = \frac{3}{2}$   
 $\csc \phi = -\frac{3\sqrt{5}}{5}$   
 $\cot \phi = -\frac{2\sqrt{5}}{5}$
9.  $\sin x = \frac{1}{3}$   
 $\cos x = -\frac{2\sqrt{2}}{3}$   
 $\tan x = -\frac{\sqrt{2}}{4}$   
 $\csc x = 3$   
 $\sec x = -\frac{3\sqrt{2}}{4}$   
 $\cot x = -2\sqrt{2}$
11.  $\sin \theta = -\frac{2\sqrt{5}}{5}$   
 $\cos \theta = -\frac{\sqrt{5}}{5}$   
 $\tan \theta = 2$   
 $\csc \theta = -\frac{\sqrt{5}}{2}$   
 $\sec \theta = -\sqrt{5}$   
 $\cot \theta = \frac{1}{2}$
13.  $\sin \theta = -1$   
 $\cos \theta = 0$   
 $\tan \theta$  is undefined.  
 $\cot \theta = 0$   
 $\csc \theta = -1$   
 $\sec \theta$  is undefined.
15. d   16. a   17. b   18. f   19. e   20. c  
21. b   22. c   23. f   24. a   25. e   26. d  
27.  $\csc \theta$    29.  $\cos^2 \phi$    31.  $\cos x$    33.  $\sin^2 x$   
35. 1   37.  $\tan x$    39.  $1 + \sin y$    41.  $\sec \beta$   
43.  $\cos u + \sin u$    45.  $\sin^2 x$    47.  $\sin^2 x \tan^2 x$   
49.  $\sec x + 1$    51.  $\sec^4 x$    53.  $\sin^2 x - \cos^2 x$   
55.  $\cot^2 x (\csc x - 1)$    57.  $1 + 2 \sin x \cos x$   
59.  $4 \cot^2 x$    61.  $2 \csc^2 x$    63.  $2 \sec x$   
65.  $1 + \cos y$    67.  $3(\sec x + \tan x)$

**A148** Answers to Odd-Numbered Exercises and Tests



$x$	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

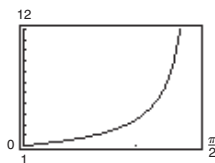
$x$	1.2	1.4
$y_1$	0.9320	0.9854
$y_2$	0.9320	0.9854

$y_1 = y_2$

71. 

$x$	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



$y_1 = y_2$

73.  $\csc x$     75.  $\tan x$     77.  $3 \sin \theta$     79.  $3 \tan \theta$

81.  $5 \sec \theta$     83.  $3 \cos \theta = 3$ ;  $\sin \theta = 0$ ;  $\cos \theta = 1$

85.  $4 \sin \theta = 2\sqrt{2}$ ;  $\sin \theta = \frac{\sqrt{2}}{2}$ ;  $\cos \theta = \frac{\sqrt{2}}{2}$

87.  $0 \leq \theta \leq \pi$     89.  $0 \leq \theta < \frac{\pi}{2}$ ,  $\frac{3\pi}{2} < \theta < 2\pi$

91.  $\ln|\cot x|$     93.  $\ln|\csc t \sec t|$

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

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

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

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

99.  $\mu = \tan \theta$

101. True. For example,  $\sin(-x) = -\sin x$ .

103. 1, 1    105.  $\infty, 0$

107. Not an identity because  $\cos \theta = \pm\sqrt{1 - \sin^2 \theta}$

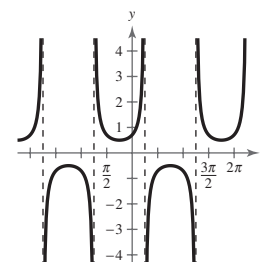
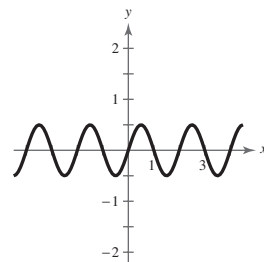
109. Not an identity because  $\frac{\sin k\theta}{\cos k\theta} = \tan k\theta$

111. An identity because  $\sin \theta \cdot \frac{1}{\sin \theta} = 1$

113. Answers will vary.    115.  $x - 25$

117.  $\frac{x^2 + 6x - 8}{(x + 5)(x - 8)}$     119.  $\frac{-5x^2 + 8x + 28}{(x^2 - 4)(x + 4)}$

121.    123.



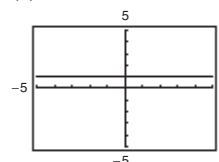
**Section 5.2** (page 387)

**Vocabulary Check** (page 387)

1. identity    2. conditional equation    3.  $\tan u$   
 4.  $\cot u$     5.  $\cos^2 u$     6.  $\sin u$     7.  $-\csc u$   
 8.  $\sec u$

1–37. Answers will vary.

39. (a)



(b)

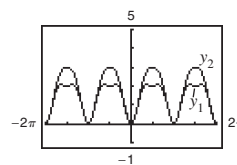
$X$	$Y_1$	$Y_2$
0	1	1
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
7	1	1
8	1	1
9	1	1
10	1	1
11	1	1
12	1	1

$X = -3$

Identity

(c) Answers will vary.

41. (a)



(b)

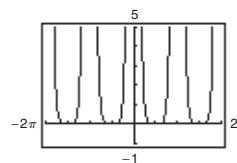
$X$	$Y_1$	$Y_2$
0	2.442	2
1	1.871	2
2	0	2
3	1.871	2
4	2.442	2
5	2.442	2
6	2.442	2
7	2.442	2
8	2.442	2
9	2.442	2
10	2.442	2
11	2.442	2
12	2.442	2

$X = -4.71238898038$

Not an identity

(c) Answers will vary.

43. (a)



(b)

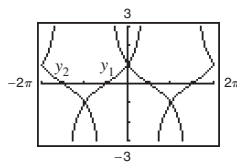
$X$	$Y_1$	$Y_2$
0	2.422	2.422
1	.04287	.04287
2	1.6998	1.6998
3	1.6998	1.6998
4	1.6998	1.6998
5	1.6998	1.6998
6	1.6998	1.6998
7	1.6998	1.6998
8	1.6998	1.6998
9	1.6998	1.6998
10	1.6998	1.6998
11	1.6998	1.6998
12	1.6998	1.6998

$X = -3$

Identity

(c) Answers will vary.

45. (a)



(b)

X	Y1	Y2
-3	-.8676	-1.153
-2	-.218	-4.588
-1	2.9341	3.4082
0	3.4082	2.9341
1	-4.588	-.218
2	-1.153	-.8676

Not an identity

(c) Answers will vary.

47 and 49. Answers will vary. 51. 1 53. 2

55. Answers will vary.

57. False. An identity is an equation that is true for all real values of  $\theta$ .59. The equation is not an identity because  $\sin \theta = \pm\sqrt{1 - \cos^2 \theta}$ .Possible answer:  $\frac{7\pi}{4}$ 61.  $2 + (3 - \sqrt{26})i$  63.  $-8 + 4i$ 65.  $-3 \pm \sqrt{21}$  67.  $1 \pm \sqrt{5}$ 

## Section 5.3 (page 396)

## Vocabulary Check (page 396)

1. general 2. quadratic 3. extraneous

1-5. Answers will vary. 7.  $\frac{2\pi}{3} + 2n\pi, \frac{4\pi}{3} + 2n\pi$ 9.  $\frac{\pi}{3} + 2n\pi, \frac{2\pi}{3} + 2n\pi$  11.  $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi$ 13.  $n\pi, \frac{3\pi}{2} + 2n\pi$  15.  $\frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$ 17.  $\frac{\pi}{8} + \frac{n\pi}{2}, \frac{3\pi}{8} + \frac{n\pi}{2}$  19.  $\frac{n\pi}{3}, \frac{\pi}{4} + n\pi$ 21.  $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$  23.  $0, \pi, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$ 25.  $\frac{\pi}{3}, \frac{5\pi}{3}, \pi$  27. No solution 29.  $\pi, \frac{\pi}{3}, \frac{5\pi}{3}$ 31.  $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$  33.  $\frac{\pi}{2}$  35.  $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi$ 37.  $\frac{\pi}{12} + \frac{n\pi}{3}$  39.  $\frac{\pi}{2} + 4n\pi, \frac{7\pi}{2} + 4n\pi$  41.  $-1 + 4n$ 43.  $-2 + 6n, 2 + 6n$  45. 2.678, 5.820

47. 1.047, 5.236 49. 0.860, 3.426

51. 0, 2.678, 3.142, 5.820

53. 0.983, 1.768, 4.124, 4.910

55. 0.3398, 0.8481, 2.2935, 2.8018

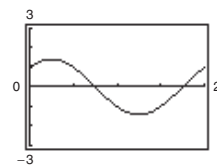
57. 1.9357, 2.7767, 5.0773, 5.9183

59.  $\frac{\pi}{4}, \frac{5\pi}{4}, \arctan 5, \arctan 5 + \pi$  61.  $\frac{\pi}{3}, \frac{5\pi}{3}$ 

## Answers to Odd-Numbered Exercises and Tests

A149

63. (a)

(b)  $\frac{\pi}{4} \approx 0.7854$  $\frac{5\pi}{4} \approx 3.9270$ 

Maximum: (0.7854, 1.4142)

Minimum: (3.9270, -1.4142)

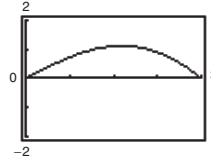
65. 1

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

(c) Oscillates (d) Infinitely many solutions

(e) Yes, 0.6366

69. 0.04 second, 0.43 second, 0.83 second

71. February, March, and April 73.  $36.9^\circ, 53.1^\circ$ 75. (a) Between  $t = 8$  seconds and  $t = 24$  seconds(b) 5 times:  $t = 16, 48, 80, 112, 144$  seconds77. (a)  $\frac{2}{3}$  (b)  $0.6 < x < 1.1$  $A \approx 1.12$ 79. True. The first equation has a smaller period than the second equation, so it will have more solutions in the interval  $[0, 2\pi)$ .81. 1 83.  $C = 24^\circ$  $a \approx 54.8$  $b \approx 50.1$ 85.  $\sin 390^\circ = \frac{1}{2}$  87.  $\sin(-1845^\circ) = -\frac{\sqrt{2}}{2}$  $\cos 390^\circ = \frac{\sqrt{3}}{2}$   $\cos(-1845^\circ) = \frac{\sqrt{2}}{2}$  $\tan 390^\circ = \frac{\sqrt{3}}{3}$   $\tan(-1845^\circ) = -1$ 89.  $1.36^\circ$  91. Answers will vary.

## Section 5.4 (page 404)

## Vocabulary Check (page 404)

1.  $\sin u \cos v - \cos u \sin v$ 2.  $\cos u \cos v - \sin u \sin v$  3.  $\frac{\tan u + \tan v}{1 - \tan u \tan v}$ 4.  $\sin u \cos v + \cos u \sin v$ 5.  $\cos u \cos v + \sin u \sin v$  6.  $\frac{\tan u - \tan v}{1 + \tan u \tan v}$ 1. (a)  $\frac{-\sqrt{2} - \sqrt{6}}{4}$  (b)  $\frac{-1 + \sqrt{2}}{2}$

**A150** Answers to Odd-Numbered Exercises and Tests

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

17.  $\sin(-165^\circ) = -\frac{\sqrt{2}}{4}(\sqrt{3} - 1)$

$\cos(-165^\circ) = -\frac{\sqrt{2}}{4}(1 + \sqrt{3})$

$\tan(-165^\circ) = 2 - \sqrt{3}$

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

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

$\tan \frac{13\pi}{12} = 2 - \sqrt{3}$

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

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

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

23.  $\cos 40^\circ$  25.  $\tan 239^\circ$  27.  $\sin 1.8$  29.  $\tan 3x$

31.  $-\frac{\sqrt{3}}{2}$  33.  $\frac{\sqrt{3}}{2}$  35.  $-1$  37.  $-\frac{63}{65}$

39.  $\frac{16}{65}$  41.  $-\frac{63}{16}$  43.  $\frac{65}{56}$  45.  $\frac{3}{5}$  47.  $-\frac{44}{117}$

49.  $\frac{5}{3}$  51. 1 53. 0 55–63. Answers will vary.

65.  $-\sin x$  67.  $-\cos \theta$  69.  $\frac{\pi}{2}$  71.  $\frac{5\pi}{4}, \frac{7\pi}{4}$

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

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

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

77. False.  $\sin(u \pm v) = \sin u \cos v \pm \cos u \sin v$

79. False.

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

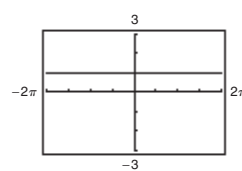
81–83. Answers will vary.

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

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

89.  $2 \cos \theta$  91. Proof 93.  $15^\circ$

95.



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

97.  $f^{-1}(x) = \frac{x + 15}{5}$

99. Because  $f$  is not one-to-one,  $f^{-1}$  does not exist.

101.  $4x - 3$  103.  $6x - 3$

**Section 5.5** (page 415)**Vocabulary Check** (page 415)

1.  $2 \sin u \cos u$  2.  $\cos^2 u$

3.  $\cos^2 u - \sin^2 u = 2 \cos^2 u - 1 = 1 - 2 \sin^2 u$

4.  $\tan^2 u$  5.  $\pm \sqrt{\frac{1 - \cos u}{2}}$

6.  $\frac{1 - \cos u}{\sin u} = \frac{\sin u}{1 + \cos u}$

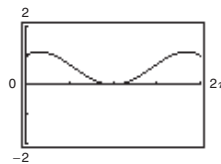
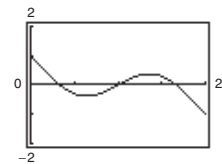
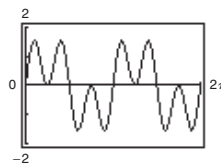
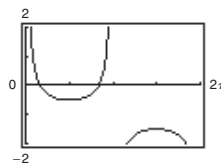
7.  $\frac{1}{2}[\cos(u - v) + \cos(u + v)]$

8.  $\frac{1}{2}[\sin(u + v) + \sin(u - v)]$

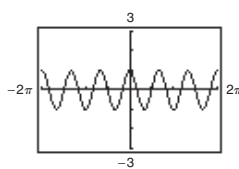
9.  $2 \sin\left(\frac{u + v}{2}\right) \cos\left(\frac{u - v}{2}\right)$

10.  $-2 \sin\left(\frac{u + v}{2}\right) \sin\left(\frac{u - v}{2}\right)$

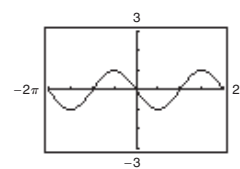
1.  $\frac{\sqrt{17}}{17}$     3.  $\frac{15}{17}$     5.  $\frac{8}{15}$     7.  $\frac{17}{8}$     9.  $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}$
11.  $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$     13.  $0, \frac{2\pi}{3}, \frac{4\pi}{3}$
15.  $\frac{\pi}{2}, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{3\pi}{2}, \frac{11\pi}{6}$     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.  $\sin 2u = \frac{24}{25}$   
 $\cos 2u = -\frac{7}{25}$      $\cos 2u = \frac{7}{25}$   
 $\tan 2u = -\frac{24}{7}$      $\tan 2u = \frac{24}{7}$
27.  $\sin 2u = -\frac{4\sqrt{21}}{25}$     29.  $\frac{1}{8}(3 + 4 \cos 2x + \cos 4x)$   
 $\cos 2u = -\frac{17}{25}$   
 $\tan 2u = \frac{4\sqrt{21}}{17}$
31.  $\frac{1}{8}(1 - \cos 4x)$
33.  $\frac{1}{16}(1 + \cos 2x - \cos 4x - \cos 2x \cos 4x)$
35.  $\frac{4\sqrt{17}}{17}$     37.  $\frac{1}{4}$     39.  $\sqrt{17}$
41.  $\sin 75^\circ = \frac{1}{2}\sqrt{2 + \sqrt{3}}$   
 $\cos 75^\circ = \frac{1}{2}\sqrt{2 - \sqrt{3}}$   
 $\tan 75^\circ = 2 + \sqrt{3}$
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.  $\sin \frac{\pi}{8} = \frac{1}{2}\sqrt{2 - \sqrt{2}}$     47.  $\sin \frac{3\pi}{8} = \frac{1}{2}\sqrt{2 + \sqrt{2}}$   
 $\cos \frac{\pi}{8} = \frac{1}{2}\sqrt{2 + \sqrt{2}}$      $\cos \frac{3\pi}{8} = \frac{1}{2}\sqrt{2 - \sqrt{2}}$   
 $\tan \frac{\pi}{8} = \sqrt{2} - 1$      $\tan \frac{3\pi}{8} = \sqrt{2} + 1$
49.  $\sin \frac{u}{2} = \frac{5\sqrt{26}}{26}$     51.  $\sin \frac{u}{2} = \sqrt{\frac{89 - 8\sqrt{89}}{178}}$   
 $\cos \frac{u}{2} = \frac{\sqrt{26}}{26}$      $\cos \frac{u}{2} = -\sqrt{\frac{89 + 8\sqrt{89}}{178}}$   
 $\tan \frac{u}{2} = 5$      $\tan \frac{u}{2} = \frac{8 - \sqrt{89}}{5}$
53.  $\sin \frac{u}{2} = \frac{3\sqrt{10}}{10}$   
 $\cos \frac{u}{2} = -\frac{\sqrt{10}}{10}$   
 $\tan \frac{u}{2} = -3$
55.  $|\sin 3x|$     57.  $-|\tan 4x|$

59.  $\pi$ 61.  $\frac{\pi}{3}, \pi, \frac{5\pi}{3}$ 63.  $3\left(\sin \frac{\pi}{2} + \sin 0\right)$     65.  $5(\cos 60^\circ + \cos 90^\circ)$ 67.  $\frac{1}{2}(\sin 10\theta + \sin 2\theta)$     69.  $\frac{5}{2}(\cos 8\beta + \cos 2\beta)$ 71.  $\frac{1}{2}(\cos 2y - \cos 2x)$     73.  $\frac{1}{2}(\sin 2\theta + \sin 2\pi)$ 75.  $2 \cos 4\theta \sin \theta$     77.  $2 \cos 4x \cos 2x$ 79.  $2 \cos \alpha \sin \beta$     81.  $-2 \sin \theta \sin \frac{\pi}{2}$ 83.  $\frac{\sqrt{3} + 1}{2}$     85.  $-\sqrt{2}$ 87.  $0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi, \frac{5\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4}$ 89.  $\frac{\pi}{6}, \frac{5\pi}{6}$ 91.  $\frac{25}{169}$     93.  $\frac{4}{13}$     95–109. Answers will vary.

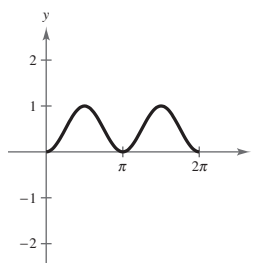
111.



113.



115.



**A152** Answers to Odd-Numbered Exercises and Tests

**117.**  $2x\sqrt{1-x^2}$     **119.**  $23.85^\circ$

**121.** (a)  $\pi$     (b) 0.4482

(c) 760 miles per hour; 3420 miles per hour

(d)  $\theta = 2 \sin^{-1}\left(\frac{1}{M}\right)$

**123.** False. For  $u < 0$ ,

$$\begin{aligned} \sin 2u &= -\sin(-2u) \\ &= -2 \sin(-u) \cos(-u) \\ &= -2(-\sin u) \cos u \\ &= 2 \sin u \cos u. \end{aligned}$$

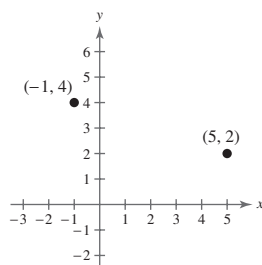
**125.** (a)  (b)  $\pi$

 Maximum:  $(\pi, 3)$ 

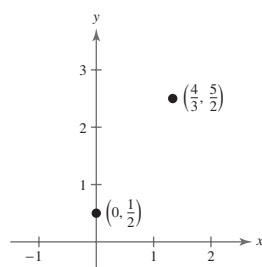
**127.** (a)  $\frac{1}{4}(3 + \cos 4x)$     (b)  $2 \cos^4 x - 2 \cos^2 x + 1$

(c)  $1 - 2 \sin^2 x \cos^2 x$     (d)  $1 - \frac{1}{2} \sin^2 2x$

(e) No. There is often more than one way to rewrite a trigonometric expression.

**129.** (a)


(b) Distance =  $2\sqrt{10}$     (c) Midpoint:  $(2, 3)$

**131.** (a)


(b) Distance =  $\frac{2}{3}\sqrt{13}$     (c) Midpoint:  $(\frac{2}{3}, \frac{3}{2})$

**133.** (a) Complement:  $35^\circ$ ; supplement:  $125^\circ$ 

 (b) No complement; supplement:  $18^\circ$ 
**135.** (a) Complement:  $\frac{4\pi}{9}$ ; supplement:  $\frac{17\pi}{18}$ 

 (b) Complement:  $\frac{\pi}{20}$ ; supplement:  $\frac{11\pi}{20}$ 
**137.** September: \$235,000; October: \$272,600

**139.**  $\approx 127$  feet

**Review Exercises** (page 420)

**1.**  $\sec x$     **3.**  $\cos x$     **5.**  $\cot x$

**7.**  $\tan x = \frac{3}{4}$     **9.**  $\cos x = \frac{\sqrt{2}}{2}$

$\csc x = \frac{5}{3}$      $\tan x = -1$   
 $\sec x = \frac{5}{4}$      $\csc x = -\sqrt{2}$

$\cot x = \frac{4}{3}$      $\sec x = \sqrt{2}$

$\cot x = -1$

**11.**  $\sin^2 x$     **13.** 1    **15.**  $\cot \theta$     **17.**  $\cot^2 x$

**19.**  $\sec x + 2 \sin x$     **21.**  $-2 \tan^2 \theta$

**23–31.** Answers will vary.

**33.**  $\frac{\pi}{3} + 2n\pi, \frac{2\pi}{3} + 2n\pi$     **35.**  $\frac{\pi}{6} + n\pi$

**37.**  $\frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$     **39.**  $0, \frac{2\pi}{3}, \frac{4\pi}{3}$     **41.**  $0, \frac{\pi}{2}, \pi$

**43.**  $\frac{\pi}{8}, \frac{3\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}$

**45.**  $0, \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}$     **47.**  $0, \pi$

**49.**  $\arctan(-4) + \pi, \arctan(-4) + 2\pi, \arctan 3, \pi + \arctan 3$

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

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

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

**53.**  $\sin \frac{25\pi}{12} = \frac{\sqrt{2}}{4}(\sqrt{3} - 1)$

$\cos \frac{25\pi}{12} = \frac{\sqrt{2}}{4}(\sqrt{3} + 1)$

$\tan \frac{25\pi}{12} = 2 - \sqrt{3}$

**55.**  $\sin 15^\circ$     **57.**  $\tan 35^\circ$     **59.**  $-\frac{3}{52}(5 + 4\sqrt{7})$

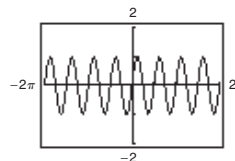
**61.**  $\frac{1}{52}(5\sqrt{7} + 36)$     **63.**  $\frac{1}{52}(5\sqrt{7} - 36)$

**65–69.** Answers will vary.    **71.**  $\frac{\pi}{4}, \frac{7\pi}{4}$     **73.**  $\frac{\pi}{6}, \frac{11\pi}{6}$

**75.**  $\sin 2u = \frac{24}{25}$

$\cos 2u = -\frac{7}{25}$

$\tan 2u = -\frac{24}{7}$

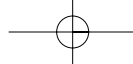
**77.**


**79.**  $\frac{1 - \cos 4x}{1 + \cos 4x}$     **81.**  $\frac{3 - 4 \cos 2x + \cos 4x}{4(1 + \cos 2x)}$

**83.**  $\sin(-75^\circ) = -\frac{1}{2}\sqrt{2 + \sqrt{3}}$

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

$\tan(-75^\circ) = -2 - \sqrt{3}$



$$85. \sin \frac{19\pi}{12} = -\frac{1}{2}\sqrt{2 + \sqrt{3}} \quad 87. \sin \frac{u}{2} = \frac{\sqrt{10}}{10}$$

$$\cos \frac{19\pi}{12} = \frac{1}{2}\sqrt{2 - \sqrt{3}} \quad \cos \frac{u}{2} = \frac{3\sqrt{10}}{10}$$

$$\tan \frac{19\pi}{12} = -2 - \sqrt{3} \quad \tan \frac{u}{2} = \frac{1}{3}$$

$$89. \sin \frac{u}{2} = \frac{3\sqrt{14}}{14} \quad 91. -|\cos 5x|$$

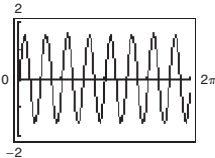
$$\cos \frac{u}{2} = \frac{\sqrt{70}}{14}$$

$$\tan \frac{u}{2} = \frac{3\sqrt{5}}{5}$$

$$93. \frac{1}{2} \sin \frac{\pi}{3} \quad 95. \frac{1}{2}(\cos 2\theta + \cos 8\theta) \quad 97. 2 \cos 3\theta \sin \theta$$

$$99. -2 \sin x \sin \frac{\pi}{6} \quad 101. \theta = 15^\circ \text{ or } \frac{\pi}{12}$$

$$103. \frac{2}{2} \sqrt{10} \text{ feet} \quad 105. \frac{1}{2}\sqrt{10} \text{ feet}$$



107. False. If  $(\pi/2) < \theta < \pi$ , then  $\cos(\theta/2) > 0$ . The sign of  $\cos(\theta/2)$  depends on the quadrant in which  $\theta/2$  lies.

$$109. \text{ True. } 4 \sin(-x) \cos(-x) = 4(-\sin x) \cos x$$

$$= -4 \sin x \cos x$$

$$= -2(2 \sin x \cos x)$$

$$= -2 \sin 2x$$

111. Reciprocal identities:

$$\sin \theta = \frac{1}{\csc \theta}, \cos \theta = \frac{1}{\sec \theta}, \tan \theta = \frac{1}{\cot \theta},$$

$$\csc \theta = \frac{1}{\sin \theta}, \sec \theta = \frac{1}{\cos \theta}, \cot \theta = \frac{1}{\tan \theta}$$

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

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

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

$$113. -1 \leq \sin x \leq 1 \text{ for all } x \quad 115. y_1 = y_2 + 1$$

$$117. -1.8431, 2.1758, 3.9903, 8.8935, 9.8820$$

### Chapter Test (page 423)

$$1. \sin \theta = -\frac{3\sqrt{13}}{13} \quad 2. 1 \quad 3. 1 \quad 4. \csc \theta \sec \theta$$

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

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

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

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

### Answers to Odd-Numbered Exercises and Tests

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$$5. \theta = 0, \frac{\pi}{2} < \theta \leq \pi, \frac{3\pi}{2} < \theta < 2\pi$$

6. 7-12. Answers will vary.

$$13. \frac{1}{16} \left( \frac{10 - 15 \cos 2x + 6 \cos 4x - \cos 6x}{1 + \cos 2x} \right) \quad 14. \tan 2\theta$$

$$15. 2(\sin 6\theta + \sin 2\theta) \quad 16. -2 \cos \frac{7\theta}{2} \sin \frac{\theta}{2}$$

$$17. 0, \frac{3\pi}{4}, \pi, \frac{7\pi}{4} \quad 18. \frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{3\pi}{2}$$

$$19. \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6} \quad 20. \frac{\pi}{6}, \frac{5\pi}{6}, \frac{3\pi}{2}$$

$$21. -2.938, -2.663, 1.170 \quad 22. \frac{\sqrt{2} - \sqrt{6}}{4}$$

$$23. \sin 2u = \frac{4}{5}, \tan 2u = -\frac{4}{3}, \cos 2u = -\frac{3}{5}$$

24. Day 123 to day 223

25.  $t = 0.26$  minute

0.58 minute

0.89 minute

1.20 minutes

1.52 minutes

1.83 minutes

### Problem Solving (page 427)

$$1. (a) \cos \theta = \pm \sqrt{1 - \sin^2 \theta}$$

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

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

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

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

$$(b) \sin \theta = \pm \sqrt{1 - \cos^2 \theta}$$

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

$$\csc \theta = \pm \frac{1}{\sqrt{1 - \cos^2 \theta}}$$

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

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

3. Answers will vary. 5.  $u + v = w$

