

Chapter 13 continued

c. $51^\circ + 12^\circ = 63^\circ$

I found the angle between straight down and the far side of the island (63°). Then I found $\tan 63^\circ = \frac{x+w}{3000}$ and then subtracted x from part (b) to get w .

$$\tan 63^\circ = \frac{D}{3000}$$

$$D = 5887.83 \text{ ft}$$

$$W = 5887.83 - 3704.7 \text{ ft}$$

$$W = 2183.13 \text{ ft}$$

52. All are right triangles with angle A in common, so they are similar by the AA Similarity Postulate.
 53. They are all equal; no; no.
 54. Yes; the ratios that define the other trigonometric functions will also be equal since corresponding ratios of similar triangles are congruent.

13.1 Mixed Review (p. 775)

55. $(3.5 \text{ hours}) \cdot \frac{45 \text{ miles}}{1 \text{ hour}} = 157.5 \text{ miles}$
 56. $(500 \text{ dollars}) \cdot \frac{12.2 \text{ schillings}}{1 \text{ dollar}} = 6100 \text{ schillings}$
 57. $\frac{3 \text{ dollars}}{1 \text{ square foot}} \cdot 1222 \text{ square feet} = \3666
 58. $(12 \text{ seconds}) \cdot \frac{254 \text{ feet}}{1 \text{ second}} = 3048 \text{ ft}$
 59. parabola 60. ellipse 61. circle 62. hyperbola
 63. $\frac{15 \cdot 14 \cdot 13 \cdot 12 \cdot 11 \cdot 10}{15 \cdot 15 \cdot 15 \cdot 15 \cdot 15 \cdot 15} = \frac{3603600}{11390625} = 0.316$

Math and History (p. 775)

1. $\sin 67^\circ = \frac{r}{2865}$

$$0.9205 = \frac{r}{2865}$$

$$r = 2637.25 \text{ miles}$$

2. $C = 2\pi(2637)$
 $= 16,568.76$

$$\frac{1}{6} \cdot 16,568.76 \approx 2761.5 \text{ miles}$$

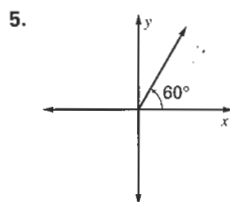
3. About 12,600 miles. Columbus's estimation of the radius of Earth at the equator was about 1100 miles short and the distance west nearly 10,000 miles short. The latitude he used for the Canary Islands was about 5° off, and for Japan was several more degrees off.

Lesson 13.2

13.2 Guided Practice (p. 780)

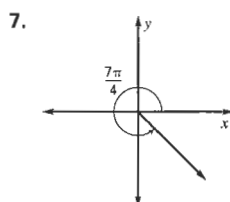
- A radian is a unit of angle measure equal to the angle that intercepts an arc of length r units in a circle of radius r .
- To find the area of a sector with this formula, you must use radian measure for the angle. The correct value is about 5.45 in.^2 .
- If the sign is positive, the terminal side is rotated counter-clockwise. If the sign is negative, the terminal side is rotated clockwise.

4. $r\pi$



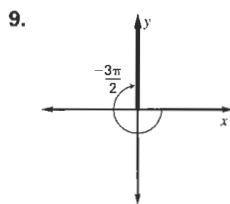
$$60 + 360 = 420^\circ$$

$$60 - 360 = -300^\circ$$



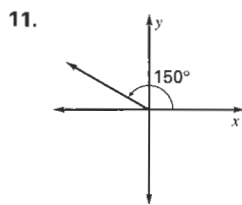
$$\frac{7\pi}{4} + 2\pi = \frac{15\pi}{4}$$

$$\frac{7\pi}{4} - 2\pi = -\frac{\pi}{4}$$



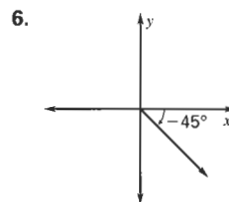
$$-\frac{3\pi}{2} + 2\pi = \frac{\pi}{2}$$

$$-\frac{3\pi}{2} - 2\pi = -\frac{7\pi}{2}$$



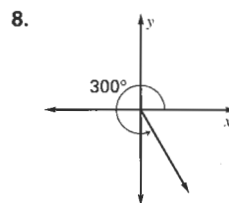
$$150 + 360 = 510^\circ$$

$$150 - 360 = -210^\circ$$



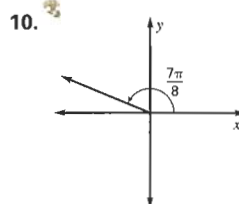
$$-45 + 360 = 315^\circ$$

$$-45 - 360 = -405^\circ$$



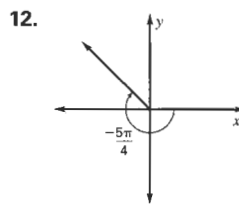
$$300 + 360 = 660^\circ$$

$$300 - 360 = -60^\circ$$



$$\frac{7\pi}{8} - 2\pi = -\frac{9\pi}{8}$$

$$\frac{7\pi}{8} + 2\pi = \frac{23\pi}{8}$$



$$-\frac{5\pi}{4} + 2\pi = \frac{3\pi}{4}$$

$$-\frac{5\pi}{4} - 2\pi = -\frac{13\pi}{4}$$

Chapter 13 continued

$$13. 30^\circ \left(\frac{\pi}{180} \right) = \frac{30\pi}{180} = \frac{\pi}{6} \quad 14. 100^\circ \left(\frac{\pi}{180} \right) = \frac{100\pi}{180} = \frac{5\pi}{9}$$

$$15. 260^\circ \left(\frac{\pi}{180} \right) = \frac{260\pi}{180} = \frac{13\pi}{9}$$

$$16. -320^\circ \left(\frac{\pi}{180} \right) = \frac{-320\pi}{180} = \frac{-16\pi}{9}$$

$$17. \frac{7\pi}{4} \left(\frac{180}{\pi} \right) = \frac{7}{4} \left(\frac{180}{1} \right) = 315^\circ$$

$$18. \frac{18\pi}{4} \left(\frac{180}{\pi} \right) = \frac{18}{4} \left(\frac{180}{1} \right) = 810^\circ$$

$$19. \frac{\pi}{12} \left(\frac{180}{\pi} \right) = \frac{180}{12} = 15^\circ$$

$$20. -\frac{5\pi}{2} \left(\frac{180}{\pi} \right) = \frac{-5}{2} \left(\frac{180}{1} \right) = -450^\circ$$

$$21. S = r\theta$$

$$55^\circ \left(\frac{\pi}{180} \right) = \frac{11\pi}{36}$$

$$S = 4 \left(\frac{11\pi}{36} \right) = \frac{11\pi}{9} \text{ in.}$$

$$A = \frac{1}{2} r^2 \theta$$

$$A = \frac{1}{2} (4^2) \left(\frac{11\pi}{36} \right) = \frac{2}{8} \left(\frac{11\pi}{36} \right) = \frac{22\pi}{9} \text{ in.}^2$$

$$22. 135^\circ \left(\frac{\pi}{180} \right) = \frac{135\pi}{180} = \frac{3\pi}{4}$$

$$S = 5 \left(\frac{3\pi}{4} \right) = \frac{15\pi}{4} \text{ m}$$

$$A = \frac{1}{2} (5^2) \left(\frac{3\pi}{4} \right) = \frac{25}{2} \left(\frac{3\pi}{4} \right) = \frac{75\pi}{8} \text{ m}^2$$

$$23. 85^\circ \left(\frac{\pi}{180} \right) = \frac{85\pi}{180} = \frac{17\pi}{36}$$

$$S = 2 \left(\frac{17\pi}{36} \right) = \frac{17\pi}{18} \text{ cm}$$

$$A = \frac{1}{2} (2^2) \left(\frac{17\pi}{36} \right) = \frac{1}{2} \left(\frac{17\pi}{36} \right) = \frac{17\pi}{18} \text{ cm}^2$$

$$24. \theta = \frac{130}{60} (2\pi) = \frac{13\pi}{3} \text{ radians}$$

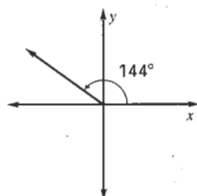
$$r = 47.25 \text{ ft}$$

$$s = r\theta = 47.25 \left(\frac{13\pi}{3} \right) \approx 643.24 \text{ ft}$$

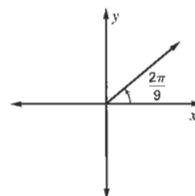
13.2 Practice and Applications (p. 780)

25. C 26. B 27. A

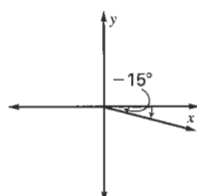
28.



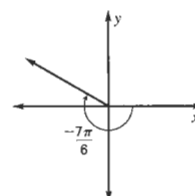
29.



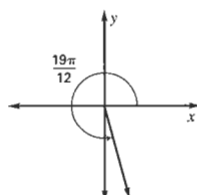
30.



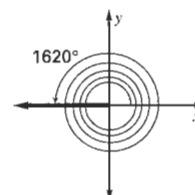
31.



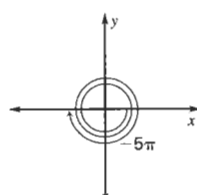
32.



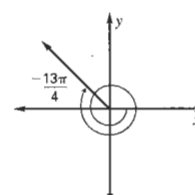
33.



34.



35.



$$36. 55 + 360 = 415^\circ$$

$$55 - 360 = -305^\circ$$

$$38. 420 - 2(360) = -300^\circ$$

$$420 - 360 = 60^\circ$$

$$40. \frac{13\pi}{2} - 4(2\pi) = \frac{-3\pi}{2}$$

$$\frac{13\pi}{2} - 2\pi = \frac{9\pi}{2}$$

$$42. \frac{24\pi}{7} - 2\pi = \frac{10\pi}{7}$$

$$\frac{24\pi}{7} - 2(2\pi) = \frac{-4\pi}{7}$$

$$44. 25^\circ \left(\frac{\pi}{180} \right) = \frac{25\pi}{180} = \frac{5\pi}{36}$$

$$46. 160^\circ \left(\frac{\pi}{180} \right) = \frac{160\pi}{180} = \frac{8\pi}{9}$$

$$48. -110^\circ \left(\frac{\pi}{180} \right) = \frac{-110\pi}{180} = \frac{-11\pi}{18}$$

$$37. 210 - 360 = -150^\circ$$

$$210 + 360 = 570^\circ$$

$$39. 780 - 2(360) = 60^\circ$$

$$780 - 3(360) = -300^\circ$$

$$41. \frac{17\pi}{4} - 2(2\pi) = \frac{\pi}{4}$$

$$\frac{17\pi}{4} - 3(2\pi) = \frac{-7\pi}{4}$$

$$43. \frac{16\pi}{3} - 2(2\pi) = \frac{4\pi}{3}$$

$$\frac{16\pi}{3} - 3(2\pi) = \frac{-2\pi}{3}$$

$$45. 225^\circ \left(\frac{\pi}{180} \right) = \frac{225\pi}{180} = \frac{5\pi}{4}$$

$$47. 45^\circ \left(\frac{\pi}{180} \right) = \frac{45\pi}{180} = \frac{\pi}{4}$$

Chapter 13 continued

$$49. 325^\circ \left(\frac{\pi}{180} \right) = \frac{325\pi}{180} = \frac{65\pi}{36}$$

$$50. 400^\circ \left(\frac{\pi}{180} \right) = \frac{400\pi}{180} = \frac{20\pi}{9}$$

$$51. -290^\circ \left(\frac{\pi}{180} \right) = -\frac{290\pi}{180} = -\frac{29\pi}{18}$$

$$52. \frac{7\pi}{3} \left(\frac{180}{\pi} \right) = \frac{7}{3} \left(\frac{180}{1} \right) = 420^\circ$$

$$53. -\frac{9\pi}{2} \left(\frac{180}{\pi} \right) = -\frac{9}{2} \left(\frac{180}{2} \right) = -810^\circ$$

$$54. \frac{\pi}{10} \left(\frac{180}{\pi} \right) = \frac{180}{10} = 18^\circ$$

$$55. -\frac{5\pi}{12} \left(\frac{180}{\pi} \right) = -\frac{5}{12} \left(\frac{180}{1} \right) = -75^\circ$$

$$56. \frac{7\pi}{15} \left(\frac{180}{\pi} \right) = \frac{7}{15} \left(\frac{180}{1} \right) = 84^\circ$$

$$57. -\frac{15\pi}{4} \left(\frac{180}{\pi} \right) = -\frac{15}{4} \left(\frac{180}{1} \right) = -675^\circ$$

$$58. -\frac{5\pi}{6} \left(\frac{180}{\pi} \right) = -\frac{5}{6} \left(\frac{180}{1} \right) = -150^\circ$$

$$59. \frac{8\pi}{5} \left(\frac{180}{\pi} \right) = \frac{8}{5} \left(\frac{180}{1} \right) = 288^\circ$$

$$60. S = 3 \left(\frac{\pi}{4} \right) = \frac{3\pi}{4} \text{ in.}$$

$$A = \frac{1}{2} (3^2) \left(\frac{\pi}{4} \right) = \frac{9}{2} \cdot \frac{\pi}{4} = \frac{9\pi}{8} \text{ in.}^2$$

$$61. S = 3 \left(\frac{\pi}{18} \right) = \frac{\pi}{6} \text{ ft}$$

$$A = \frac{1}{2} (3^2) \left(\frac{\pi}{18} \right) = \frac{9}{2} \left(\frac{\pi}{18} \right) = \frac{\pi}{4} \text{ ft}^2$$

$$62. S = 2 \left(\frac{9\pi}{20} \right) = \frac{9\pi}{10} \text{ cm}$$

$$A = \frac{1}{2} (2^2) \left(\frac{9\pi}{20} \right) = \frac{4}{2} \left(\frac{9\pi}{20} \right) = \frac{9\pi}{10} \text{ cm}^2$$

$$63. 90^\circ \left(\frac{\pi}{180} \right) = \frac{\pi}{2}$$

$$S = 12 \left(\frac{\pi}{2} \right) = 6\pi \text{ in.}$$

$$A = \frac{1}{2} (12^2) \left(\frac{\pi}{2} \right) = \frac{144}{2} \left(\frac{\pi}{2} \right) = 36\pi \text{ in.}^2$$

$$64. 120^\circ \left(\frac{\pi}{180} \right) = \frac{120\pi}{180} = \frac{2\pi}{3}$$

$$S = 5 \left(\frac{2\pi}{3} \right) = \frac{10\pi}{3} \text{ m}$$

$$A = \frac{1}{2} (5^2) \left(\frac{2\pi}{3} \right) = \frac{25}{2} \left(\frac{2\pi}{3} \right) = \frac{25\pi}{3} \text{ m}^2$$

$$65. 175^\circ \left(\frac{\pi}{180} \right) = \frac{175\pi}{180} = \frac{35\pi}{36}$$

$$S = \frac{5}{15} \left(\frac{35\pi}{36} \right) = \frac{175\pi}{12} \text{ mm}$$

$$A = \frac{1}{2} (15^2) \left(\frac{35\pi}{36} \right) = \frac{225}{2} \left(\frac{35\pi}{36} \right) = \frac{875\pi}{8} \text{ mm}^2$$

$$66. 200^\circ \left(\frac{\pi}{180} \right) = \frac{200\pi}{180} = \frac{10\pi}{9}$$

$$S = 4 \left(\frac{10\pi}{9} \right) = \frac{40\pi}{9} \text{ ft}$$

$$A = \frac{1}{2} (4^2) \left(\frac{10\pi}{9} \right) = \frac{16}{2} \left(\frac{10\pi}{9} \right) = \frac{80\pi}{9} \text{ ft}^2$$

$$67. 50^\circ \left(\frac{\pi}{180} \right) = \frac{50\pi}{180} = \frac{5\pi}{18}$$

$$S = 16 \left(\frac{5\pi}{18} \right) = \frac{40\pi}{9} \text{ cm}$$

$$A = \frac{1}{2} (16^2) \left(\frac{5\pi}{18} \right) = \frac{128}{1} \left(\frac{5\pi}{18} \right) = \frac{320\pi}{9} \text{ cm}^2$$

$$68. 270^\circ \left(\frac{\pi}{180} \right) = \frac{270\pi}{180} = \frac{3\pi}{2}$$

$$S = 20 \left(\frac{3\pi}{2} \right) = 30\pi \text{ ft}$$

$$A = \frac{1}{2} (20^2) \left(\frac{3\pi}{2} \right) = 200 \left(\frac{3\pi}{2} \right) = 300\pi \text{ ft}^2$$

$$69. \sin \frac{\pi}{6} = \frac{1}{2} \quad 70. \cos \frac{\pi}{4} = \frac{\sqrt{2}}{2} \quad 71. \tan \frac{\pi}{3} = \sqrt{3}$$

$$72. \cos \frac{4\pi}{11} = 0.4154 \quad 73. \cot \frac{\pi}{5} = 1.3764$$

$$74. \sec \frac{\pi}{8} = 1.0824 \quad 75. \sin \frac{2\pi}{9} = 0.6428$$

$$76. \csc \frac{3\pi}{10} = 1.23 \quad 77. 360^\circ + 180^\circ = 540^\circ$$

$$540^\circ \left(\frac{\pi}{180} \right) = \frac{540\pi}{180} = 3\pi$$

$$78. 360^\circ + 360^\circ + 180^\circ = 900^\circ$$

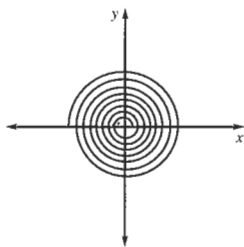
$$900^\circ \left(\frac{\pi}{180} \right) = \frac{900\pi}{180} = 5\pi$$

$$79. 360^\circ + 360^\circ + 360^\circ + 180^\circ = 1260^\circ$$

$$1260^\circ \left(\frac{\pi}{180} \right) = \frac{1260\pi}{180} = 7\pi$$

Chapter 13 continued

80.



$$7(360^\circ) = 2520^\circ$$

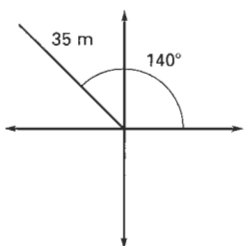
$$2520^\circ \left(\frac{\pi}{180} \right) = \frac{2520\pi}{180} = 14\pi$$

81. $\frac{24}{19} = 1.26$ rotations

$$\theta = 5.05 \left(\frac{360}{1} \right) = 1820^\circ$$

$$\frac{1820\pi}{180} = \frac{91\pi}{9} \text{ radians}$$

82.



$$140^\circ \left(\frac{\pi}{180} \right) = \frac{140\pi}{180} = \frac{7\pi}{9}$$

$$A = \frac{1}{2}(35^2) \left(\frac{7\pi}{9} \right) = \frac{1225}{2} \left(\frac{7\pi}{9} \right) = \frac{8575\pi}{18} = 1497 \text{ m}^2$$

83. $120^\circ \left(\frac{\pi}{180} \right) = \frac{120\pi}{180} = \frac{2\pi}{3}$

$$A = \frac{1}{2}(25^2) \left(\frac{2\pi}{3} \right) = \frac{625}{2} \left(\frac{2\pi}{3} \right) = \frac{625\pi}{3} = 654.50$$

$$A = \frac{1}{2}(11^2) \left(\frac{2\pi}{3} \right) = \frac{121}{2} \left(\frac{2\pi}{3} \right) = 126.71$$

Area of Windshield Wiper

$$654.50 - 126.71 = 527.8 \text{ in.}^2$$

84. $S = \frac{\pi}{7}(36) = \frac{36\pi}{7}$ in. or 16.16 in.

85. $14 \left(\frac{\pi}{7} \right) = \frac{14\pi}{7} = 2\pi$

86. $A = \frac{1}{2}(36^2) \left(\frac{\pi}{7} \right) = 648 \left(\frac{\pi}{7} \right) = 290.82$

$$290.82(13)$$

$$= 3780.7 \text{ in.}^2$$

87. $s = r\theta \quad \theta = 60^\circ \left(\frac{\pi}{180} \right) = \frac{\pi}{3}$ 88. diameter = $2r = 4$

$$= 5 \left(\frac{\pi}{3} \right)$$

$$= \frac{5\pi}{3}$$

$$C = \frac{5\pi}{3}$$

$$C = 2\pi r$$

$$\frac{5\pi}{3} = 2\pi r$$

$$\frac{5}{3} = 2r = \text{diameter.}$$

$$2\pi r = 4\pi$$

$$C = 4\pi$$

$$S = 6\theta$$

$$4\pi = 6\theta$$

$$\frac{4\pi}{6} = \theta$$

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

89. C

$$45^\circ \left(\frac{\pi}{180} \right) = \frac{45\pi}{180} = \frac{\pi}{4}$$

$$S = 2 \left(\frac{\pi}{4} \right) = \frac{\pi}{2}$$

$$S = 2.5 \left(\frac{\pi}{5} \right) = \frac{\pi}{2}$$

90. B

$$A = \frac{1}{2}(2^2) \left(\frac{\pi}{4} \right) = 2 \left(\frac{\pi}{4} \right) = \frac{\pi}{2}$$

$$A = \frac{1}{2}(2.5^2) \left(\frac{\pi}{5} \right) = \frac{6.25}{2} \left(\frac{\pi}{5} \right) = \frac{6.25\pi}{10}$$

91. $18^\circ \left(\frac{\pi}{180} \right) = \frac{18\pi}{180} = \frac{\pi}{10}$

$$A = \frac{1}{2} \left(6\frac{5}{8} \right)^2 \left(\frac{\pi}{10} \right) = \frac{1}{2} \left(\frac{532}{8} \right)^2 \left(\frac{\pi}{10} \right) = \frac{2809}{128} \left(\frac{\pi}{10} \right)$$

$$= \frac{2809\pi}{1280} \approx 6.89 \text{ in.}^2$$

Double Section:

$$A = \frac{1}{2} \left(6\frac{2}{8} \right)^2 \left(\frac{\pi}{10} \right) = \frac{1}{2} \left(\frac{25}{4} \right)^2 \frac{\pi}{10} = \frac{625\pi}{320} = 6.14$$

$$A = 6.89 - 6.14 = 0.75 \text{ in.}^2$$

Triple Section:

$$A = \frac{1}{2} \left(4\frac{1}{8} \right)^2 \left(\frac{\pi}{10} \right) = \frac{1}{2} \left(\frac{33}{8} \right)^2 \left(\frac{\pi}{10} \right) = \frac{1089\pi}{1280} = 2.67$$

$$= 2.67 - 2.209 = 0.461 \text{ in.}^2$$

$$A = \frac{1}{2} \left(3\frac{3}{4} \right)^2 \left(\frac{\pi}{10} \right) = \frac{1}{2} \left(\frac{15}{4} \right)^2 \left(\frac{\pi}{10} \right) = \frac{225\pi}{320} = 2.209$$

$$A = 2.67 - 2.209 = 0.461 \text{ in.}^2$$

92. $\frac{0.461}{6.89} = 0.067$ Triple Section

$$\frac{0.75}{6.89} = 0.109 \text{ Double Section}$$

Chapter 13 continued

13.2 Mixed Review (p. 783)

$$93. \sqrt{275} = \sqrt{25} \sqrt{11} \quad 94. \sqrt{1216} = \sqrt{64} \sqrt{19}$$

$$5\sqrt{11} \qquad \qquad \qquad = 8\sqrt{19}$$

$$95. \sqrt{8} \cdot \sqrt{32} = 2\sqrt{2} \cdot 4\sqrt{2} = 8(2) = 16$$

$$96. \sqrt{18} \cdot \sqrt{24} = \sqrt{6} \sqrt{3} \cdot \sqrt{8} \sqrt{3}$$

$$= \sqrt{2} \sqrt{3} \sqrt{3} \cdot \sqrt{4} \sqrt{2} \sqrt{3}$$

$$= 3\sqrt{2} \cdot 2\sqrt{2} \sqrt{3} = 12\sqrt{3}$$

$$97. \sqrt{\frac{7}{16}} = \frac{\sqrt{7}}{4} \quad 98. \sqrt{\frac{11}{36}} = \frac{\sqrt{11}}{\sqrt{36}} = \frac{\sqrt{11}}{6}$$

$$99. \frac{\sqrt{8}}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}} = \frac{\sqrt{56}}{7} = \frac{2\sqrt{14}}{7}$$

$$100. \frac{\sqrt{12}}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{60}}{5} = \frac{\sqrt{4} \sqrt{15}}{5} = \frac{2\sqrt{15}}{5}$$

$$101. \frac{6^2}{2(11) + 5} = \frac{36}{22 + 5} = \frac{36}{27} = \frac{4}{3}$$

$$102. \frac{3^2}{2(-3) + 5} = \frac{9}{-6 + 5} = \frac{9}{-1} = -9$$

$$103. \frac{12^2}{2(15) + 5} = \frac{144}{30 + 5} = \frac{144}{35}$$

$$104. \frac{-1^2}{2(-5) + 5} = \frac{1}{-10 + 5} = \frac{1}{-5}$$

$$105. \frac{-10^2}{2(16) + 5} = \frac{100}{32 + 5} = \frac{100}{37}$$

$$106. \frac{-20^2}{2(-25) + 5} = \frac{400}{-45} = \frac{-80}{9}$$

$$107. y^2 = 20x \quad 108. y^2 = -12x \quad 109. y^2 = 24x$$

$$110. x^2 = -48y \quad 111. x^2 = -17.6y \quad 112. x^2 = 60y$$

Quiz 1 (p. 783)

$$1. \sin \theta = \frac{8}{17}, \cos \theta = \frac{15}{17}$$

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

$$\csc \theta = \frac{17}{8}, \sec \theta = \frac{17}{15}$$

$$8^2 + x^2 = 17^2$$

$$64 + x^2 = 289$$

$$x^2 = 225$$

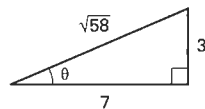
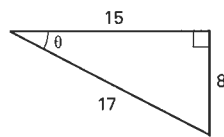
$$x = 15$$

$$2. \sin \theta = \frac{3\sqrt{58}}{58}, \cos \theta = \frac{7\sqrt{58}}{58}$$

$$\tan \theta = \frac{3}{7}, \cot \theta = \frac{7}{3}$$

$$\csc \theta = \frac{\sqrt{58}}{3}, \sec \theta = \frac{\sqrt{58}}{7}$$

$$7^2 + 3^2 = x^2$$



$$49 + 9 = x^2$$

$$58 = x^2$$

$$\sqrt{58} = x$$

$$3. \sin \theta = \frac{6\sqrt{61}}{61}, \cos \theta = \frac{5\sqrt{61}}{61}$$

$$\tan \theta = \frac{6}{5}, \cot \theta = \frac{5}{6}$$

$$\csc \theta = \frac{\sqrt{61}}{6}, \sec \theta = \frac{\sqrt{61}}{5}$$

$$5^2 + x^2 = \sqrt{61}^2$$

$$25 + x^2 = 61$$

$$x^2 = 36$$

$$x = 6$$

$$4. 90^\circ + 50^\circ = 140^\circ$$

$$180^\circ - 140^\circ = 40^\circ$$

$$A = 40^\circ$$

$$\cos 50^\circ = \frac{18}{c}$$

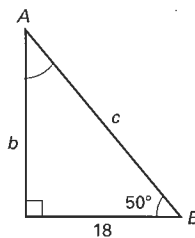
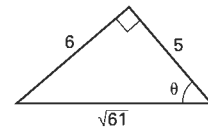
$$\sin 50^\circ = \frac{b}{28}$$

$$0.6428 = \frac{18}{c}$$

$$0.766 = \frac{b}{28}$$

$$c = 28$$

$$b = 21.45$$



$$5. 90^\circ + 33^\circ = 123^\circ$$

$$180^\circ - 123^\circ = 57^\circ$$

$$B = 57^\circ$$

$$\sin 33^\circ = \frac{a}{12}$$

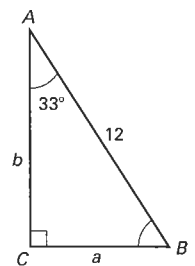
$$\cos 33^\circ = \frac{b}{12}$$

$$0.5446 = \frac{a}{12}$$

$$0.8387 = \frac{b}{12}$$

$$a = 6.54$$

$$b = 10.06$$



$$6. 90^\circ + 10^\circ = 100^\circ$$

$$180^\circ - 100^\circ = 80^\circ$$

$$B = 80^\circ$$

$$\cos 80^\circ = \frac{3}{c}$$

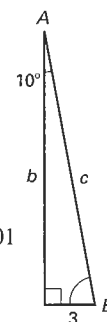
$$\tan 80^\circ = \frac{b}{3}$$

$$0.1736 = \frac{3}{c}$$

$$5.67 = \frac{b}{3}$$

$$c = 17.28$$

$$b = 17.01$$



Chapter 13 *continued*

$$7. \quad 71^\circ + 90^\circ = 161^\circ$$

$$180^\circ - 161^\circ = 19^\circ$$

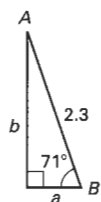
$$A = 19^\circ$$

$$\sin 71^\circ = \frac{b}{2.3} \quad \cos 71^\circ = \frac{a}{2.3}$$

$$0.9455 = \frac{b}{2.3} \quad 0.3256 = \frac{a}{2.3}$$

$$b = 2.17$$

$$a = 0.7488$$



$$8. \quad 25^\circ + 360^\circ = 385^\circ$$

$$25^\circ - 360^\circ = -335^\circ$$

$$9. \quad -\frac{14\pi}{3} + 3(2\pi) = \frac{4\pi}{3}$$

$$-\frac{14\pi}{3} + (2\pi) = \frac{-8\pi}{3}$$

$$10. \quad \frac{33\pi}{4} - 4(2\pi) = \frac{\pi}{4}$$

$$\frac{33\pi}{4} - 5(2\pi) = \frac{-7\pi}{4}$$

$$11. \quad -6200^\circ + 17(360^\circ) = -80^\circ$$

$$-6200^\circ + 18(360^\circ) = 280^\circ$$

$$12. \quad S = 6\left(\frac{\pi}{3}\right) = 2\pi \text{ m}$$

$$13. \quad S = 2\left(\frac{5\pi}{6}\right) = \frac{5\pi}{3} \text{ ft}$$

$$A = \frac{1}{2}(6^2)\left(\frac{\pi}{3}\right) = \frac{36}{2}\left(\frac{\pi}{3}\right) = 6\pi \text{ m}^2$$

$$A = \frac{1}{2}(2^2)\left(\frac{5\pi}{6}\right) = \frac{5\pi}{3} \text{ ft}^2$$

$$14. \quad \frac{20\pi}{180} = \frac{\pi}{9}$$

$$S = 8\left(\frac{\pi}{9}\right) = \frac{8\pi}{9} \text{ cm}$$

$$A = \frac{1}{2}(8^2)\left(\frac{\pi}{9}\right) = \frac{32\pi}{9} \text{ cm}^2$$

$$15. \quad \frac{220\pi}{180} = \frac{11\pi}{9}$$

$$S = 22\left(\frac{11\pi}{9}\right) = \frac{242\pi}{9} \text{ in.}$$

$$A = \frac{1}{2}(22^2)\left(\frac{11\pi}{9}\right) = \frac{2662\pi}{9} \text{ in.}^2$$

$$16. \quad \frac{75\pi}{180} = \frac{5\pi}{12}$$

$$S = 5\left(\frac{5\pi}{12}\right) = \frac{25\pi}{12} \text{ ft}$$

$$A = \frac{1}{2}(5^2)\left(\frac{5\pi}{12}\right) = \frac{25}{2}\left(\frac{5\pi}{12}\right) = \frac{125\pi}{24} \text{ ft}^2$$

$$17. \quad \frac{160\pi}{180} = \frac{8\pi}{9}$$

$$S = 12\left(\frac{8\pi}{9}\right) = \frac{32\pi}{3} \text{ mm}$$

$$A = \frac{1}{2}(12^2)\left(\frac{8\pi}{9}\right) = \frac{144}{2}\left(\frac{8\pi}{9}\right) = \frac{576\pi}{9} = 64\pi \text{ mm}^2$$

$$18. \quad 6 \text{ inch slice: } \frac{60\pi}{180} = \frac{\pi}{3}$$

$$A = \frac{1}{2}(6^2)\left(\frac{\pi}{3}\right) = \frac{36}{2}\left(\frac{\pi}{3}\right) = 6\pi = 18.85 \text{ in.}^2 \text{ for } \$1.50$$

About \$0.08/in.²

$$7 \text{ inch slice: } \frac{45\pi}{180} = \frac{\pi}{4}$$

$$A = \frac{1}{2}(7^2)\left(\frac{\pi}{4}\right) = \frac{49}{2}\left(\frac{\pi}{4}\right) = \frac{49\pi}{8} = 19.24 \text{ in.}^2 \text{ for } \$1.70$$

About \$0.09/in.²

The 6 inch slice is the better deal as the unit price is lower.

Lesson 13.3

13.3 Guided Practice (p. 788)

1. A quadrantal angle is when the terminal side of θ lies on an axis. A reference angle is the acute angle formed by the terminal side of θ and the x -axis.

2. First, find the reference angle θ . Next, evaluate the trigonometric function for the angle θ . Because θ lies in Quad III, the sign of $\sin \theta$ would be negative.

3. Because $\tan \theta = \frac{y}{x}$ and 270° would equal $(0, -r)$, it concludes that $\tan \frac{-r}{0}$ is undefined as you cannot divide by 0.

4. I or IV

$$5. \quad r = \sqrt{(-4)^2 + (-5)^2} = \sqrt{16 + 25}$$

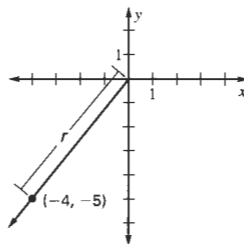
$$r = \sqrt{41}$$

$$x = -4, y = -5 \text{ and } r = \sqrt{41}$$

$$\sin \theta = \frac{-5\sqrt{41}}{41}, \cos \theta = \frac{-4\sqrt{41}}{41}$$

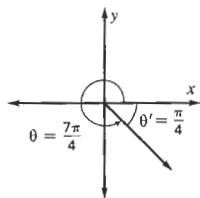
$$\tan \theta = \frac{5}{4}, \cot \theta = \frac{4}{5}$$

$$\csc \theta = \frac{\sqrt{41}}{-5}, \sec \theta = \frac{\sqrt{41}}{-4}$$

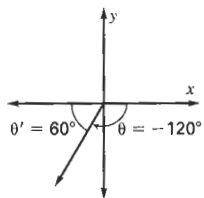


Chapter 13 continued

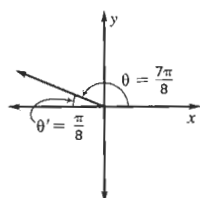
$$6. \frac{7\pi}{4} - \frac{3\pi}{2} = \frac{\pi}{4}$$



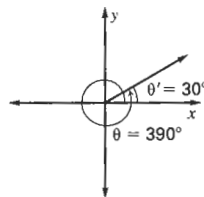
$$7. 180^\circ - 120^\circ = 60^\circ$$



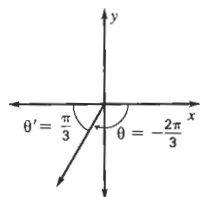
$$8. \pi - \frac{7\pi}{8} = \frac{\pi}{8}$$



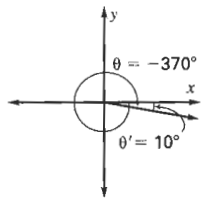
$$9. 390^\circ - 360^\circ = 30^\circ$$



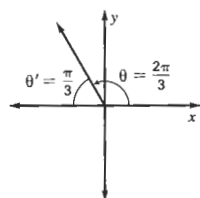
$$10. \pi - \frac{2\pi}{3} = \frac{\pi}{3}$$



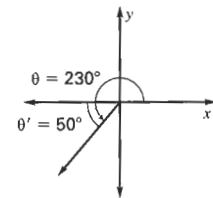
$$11. 370^\circ - 360^\circ = 10^\circ$$



$$12. \pi - \frac{2\pi}{3} = \frac{\pi}{3}$$



$$13. 230^\circ - 180^\circ = 50^\circ$$



$$14. \cos\left(-\frac{4\pi}{3}\right)$$

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

$$16. \sin \frac{7\pi}{4}$$

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

$$18. \cot\left(-\frac{3\pi}{4}\right)$$

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

$$15. \tan 240^\circ$$

$$\tan 60^\circ = \sqrt{3}$$

$$17. \csc(-225^\circ)$$

$$\csc 45^\circ = \sqrt{2}$$

$$19. \cos 240^\circ$$

$$\cos 60^\circ = -\frac{1}{2}$$

$$20. \sec \frac{11\pi}{6}$$

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

$$21. \tan \frac{5\pi}{6}$$

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

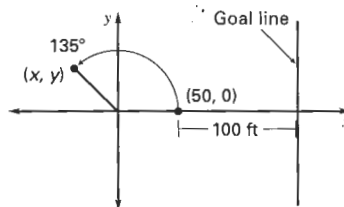
$$22. \cos 135^\circ = \frac{x}{r}$$

$$\frac{-\sqrt{2}}{2} = \frac{x}{50}$$

$$\frac{2x}{2} = \frac{-50\sqrt{2}}{2}$$

$$x = -25\sqrt{2}$$

$$100 + (50 + 25\sqrt{2}) \approx 185 \text{ ft}$$



Practice and Applications (p. 789)

$$23. r = \sqrt{(-12)^2 + 5^2} = \sqrt{144 + 25} = \sqrt{169} = 13$$

$$x = -12, y = 5, r = 13$$

$$\sin \theta = \frac{5}{13}, \cot \theta = \frac{-12}{5}$$

$$\cos \theta = \frac{-12}{13}, \csc \theta = \frac{13}{5}$$

$$\tan \theta = \frac{5}{-12}, \sec \theta = \frac{13}{-12}$$

$$24. r = \sqrt{-6^2 + -8^2} = \sqrt{36 + 64} = \sqrt{100} = 10$$

$$x = -6, y = -8, r = 10$$

$$\sin \theta = -\frac{4}{5}, \cot \theta = \frac{3}{4}$$

$$\cos \theta = -\frac{3}{5}, \csc \theta = \frac{5}{-4}$$

$$\tan \theta = \frac{4}{3}, \sec \theta = \frac{5}{-3}$$

$$25. r = \sqrt{-9^2 + 14^2} = \sqrt{81 + 196} = \sqrt{277}$$

$$x = -9, y = 14, r = \sqrt{277}$$

$$\sin \theta = \frac{14\sqrt{277}}{277}, \cot \theta = \frac{-9}{14}$$

$$\cos \theta = \frac{-9\sqrt{277}}{277}, \csc \theta = \frac{\sqrt{277}}{14}$$

$$\tan \theta = \frac{14}{-9}, \sec \theta = \frac{\sqrt{277}}{-9}$$

Chapter 13 continued

$$26. r = \sqrt{-12^2 + (-15)^2} = \sqrt{144 + 225} = \sqrt{369} \\ = \sqrt{9 \cdot 41} = 3\sqrt{41}$$

$$x = -12, y = -15, r = 3\sqrt{41}$$

$$\sin \theta = \frac{-15}{3\sqrt{41}} = \frac{-5\sqrt{41}}{41}$$

$$\cos \theta = \frac{-12}{3\sqrt{41}} = \frac{-4\sqrt{41}}{41}$$

$$\tan \theta = \frac{-15}{-12} = \frac{5}{4}$$

$$\csc \theta = \frac{3\sqrt{41}}{-15} = \frac{\sqrt{41}}{-5}$$

$$\sec \theta = \frac{3\sqrt{41}}{-12} = \frac{\sqrt{41}}{-4}$$

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

$$27. r = \sqrt{(-1)^2 + 1^2} = \sqrt{1 + 1} = \sqrt{2}$$

$$x = -1, y = 1, r = \sqrt{2}$$

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

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

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

$$28. r = \sqrt{15^2 + (-8)^2} = \sqrt{225 + 64} = \sqrt{289} = 17$$

$$x = 15, y = -8, r = 17$$

$$\sin \theta = \frac{-8}{17}, \cos \theta = \frac{15}{17}$$

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

$$\csc \theta = \frac{17}{-8}, \sec \theta = \frac{17}{15}$$

$$29. r = \sqrt{6^2 + (-9)^2} = \sqrt{36 + 81} = \sqrt{117} = 3\sqrt{13}$$

$$x = 6, y = -9, r = 3\sqrt{13}$$

$$\sin \theta = \frac{-9}{3\sqrt{13}} = \frac{-3\sqrt{13}}{13}, \cos \theta = \frac{6}{3\sqrt{13}} = \frac{2\sqrt{13}}{13}$$

$$\tan \theta = \frac{-3}{2}, \cot \theta = \frac{2}{-3}$$

$$\csc \theta = \frac{-\sqrt{13}}{3}, \sec \theta = \frac{\sqrt{13}}{2}$$

$$30. r = \sqrt{7^2 + 10^2} = \sqrt{49 + 100} = \sqrt{149}$$

$$x = 7, y = 10, r = \sqrt{149}$$

$$\sin \theta = \frac{10}{\sqrt{149}}, \cos \theta = \frac{7}{\sqrt{149}}$$

$$\tan \theta = \frac{10}{7}, \cot \theta = \frac{7}{10}$$

$$\csc \theta = \frac{\sqrt{149}}{10}, \sec \theta = \frac{\sqrt{149}}{7}$$

$$31. r = \sqrt{1^2 + (-\sqrt{3})^2} = \sqrt{1 + 3} = \sqrt{4} = 2$$

$$x = 1, y = -\sqrt{3}, r = 2$$

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

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

$$\csc \theta = -\frac{2\sqrt{3}}{3}, \sec \theta = 2$$

$$32. r = \sqrt{-3^2 + -4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$$

$$x = -3, y = -4, r = 5$$

$$\sin \theta = -\frac{4}{5}, \cos \theta = -\frac{3}{5}$$

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

$$\csc \theta = -\frac{5}{4}, \sec \theta = \frac{5}{-3}$$

$$33. r = \sqrt{(-15)^2 + (5\sqrt{7})^2} = \sqrt{225 + 175} = \sqrt{400} = 20$$

$$x = -15, y = 5\sqrt{7}, r = 20$$

$$\sin \theta = \frac{5\sqrt{7}}{20} = \frac{\sqrt{7}}{4}, \cos \theta = \frac{-15}{20} = -\frac{3}{4}$$

$$\tan \theta = \frac{5\sqrt{7}}{-15} = -\frac{\sqrt{7}}{3}, \csc \theta = \frac{20}{5\sqrt{7}} = \frac{4\sqrt{7}}{7}$$

$$\sec \theta = \frac{20}{-15} = -\frac{4}{3}, \cot \theta = \frac{-15}{5\sqrt{7}} = -\frac{3\sqrt{7}}{7}$$

$$34. \theta = 90^\circ, x = 0, y = r$$

$$\sin \theta = \frac{y}{r} = \frac{r}{r} = 1, \cos \theta = \frac{x}{r} = \frac{0}{r} = 0$$

$$\tan \theta = \frac{y}{x} = \frac{r}{0} \text{ undefined}, \cot \theta = \frac{x}{y} = \frac{0}{r} = 0$$

$$\csc \theta = \frac{r}{y} = \frac{r}{r} = 1, \sec \theta = \frac{r}{x} = \frac{r}{0} = \text{undefined}$$

$$35. \theta = 270^\circ, x = 0, y = -r$$

$$\sin \theta = \frac{y}{r} = \frac{-r}{r} = -1, \cos \theta = \frac{x}{r} = \frac{0}{r} = 0$$

$$\tan \theta = \frac{y}{x} = \frac{-r}{0} = \text{undefined}, \cot \theta = \frac{x}{y} = \frac{0}{-r} = 0$$

$$\csc \theta = \frac{r}{y} = \frac{r}{-r} = -1, \sec \theta = \frac{r}{x} = \frac{r}{0} = \text{undefined}$$

$$36. \theta = 0^\circ, x = r, y = 0$$

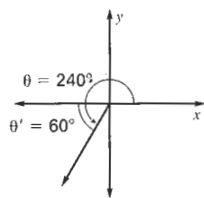
$$\sin \theta = \frac{y}{r} = \frac{0}{r} = 0, \cos \theta = \frac{x}{r} = \frac{r}{r} = 1$$

$$\tan \theta = \frac{y}{x} = \frac{0}{r} = 0, \cot \theta = \frac{x}{y} = \frac{r}{0} = \text{undefined}$$

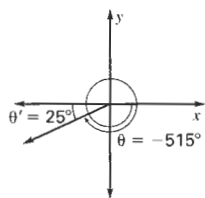
$$\csc \theta = \frac{r}{y} = \frac{r}{0} = \text{undefined}, \sec \theta = \frac{r}{x} = \frac{r}{r} = 1$$

Chapter 13 continued

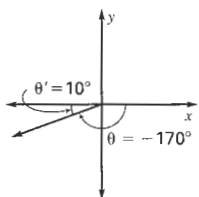
37. $240^\circ - 180^\circ = 60^\circ$



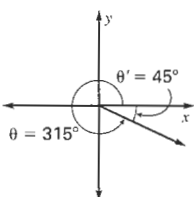
38. $-515^\circ + 540^\circ = 25^\circ$



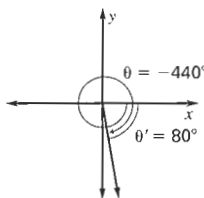
39. $180^\circ - 170^\circ = 10^\circ$



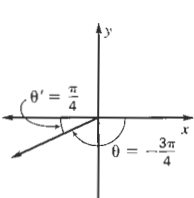
40. $\theta = 360^\circ - 315^\circ = 45^\circ$



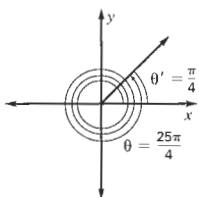
41. $440^\circ - 360^\circ = 80^\circ$



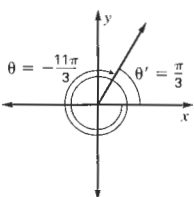
42. $\pi - \frac{3\pi}{4} = \frac{\pi}{4}$



43. $\frac{25\pi}{4} - 6\pi = \frac{\pi}{4}$



44. $4\pi - \frac{11\pi}{3} = \frac{\pi}{3}$



45. $\cos 315^\circ = \frac{\sqrt{2}}{2}$

46. $\cos(-210^\circ) = \frac{-\sqrt{3}}{2}$

47. $\csc(-240^\circ) = \frac{2\sqrt{3}}{3}$

48. $\tan 210^\circ = \frac{\sqrt{3}}{3}$

49. $\sec 780^\circ = 2$

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

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

52. $\tan(-120^\circ) = \sqrt{3}$

53. $\cot \frac{11\pi}{6} = -\sqrt{3}$

54. $\sec \frac{9\pi}{4} = \sqrt{2}$

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

56. $\cos \frac{5\pi}{3} = \frac{1}{2}$

57. $\sin\left(-\frac{17\pi}{6}\right) = -\frac{1}{2}$

58. $\sec \frac{23\pi}{6} = \frac{2\sqrt{3}}{3}$

59. $\csc \frac{17\pi}{3} = \frac{-2\sqrt{3}}{3}$

60. $\cot\left(-\frac{13\pi}{4}\right) = -1$

61. $\sec 137^\circ = -1.3673$

62. $\cot 400^\circ = 1.1918$

63. $\sin(-10^\circ) = -0.1736$

64. $\csc 540^\circ = \text{undefined}$

65. $\cot\left(-\frac{4\pi}{5}\right) = 1.3764$

66. $\sec \frac{11\pi}{2} = \text{undefined}$

67. $\cos \frac{6\pi}{5} = -0.8090$

68. $\csc \frac{23\pi}{8} = 2.6131$

69. $d = \frac{V^2}{32} \sin 2\theta$

$$5 = \frac{V^2}{32} \sin 2(18)$$

$$5 = \frac{0.5878V^2}{32}$$

$$160 = 0.5878V^2$$

$$272.2 = V^2$$

$$V = 16.5 \text{ ft/sec}$$

70. $d = \frac{V^2}{32} \sin 2\theta$

$$d = \frac{24^2}{32} \sin(2 \cdot 70)$$

$$d = \frac{576}{32} \sin 140$$

$$d = 11.57 \text{ ft}$$

71. $d = \frac{42^2}{32} \sin 2(45^\circ) = \frac{1764}{32} \sin 90^\circ = \frac{1764}{32}(1) = 55.13 \text{ ft}$

$$d = \frac{42^2}{32} \sin 2(60^\circ) = \frac{1764}{32} \sin 120^\circ = 47.74 \text{ ft}$$

$$55.13 - 47.74 = 7.4 \text{ ft farther}$$

72. $\cos 312^\circ = \frac{x}{r}$

$$0.6691 = \frac{x}{164}$$

$$109.73 = x$$

$$(164 - 109.73) + 16.5 = 70.8 \text{ ft}$$

73. $\cos 23.5^\circ = \frac{x}{r}$

$$\cos 23.5^\circ = \frac{x}{3960}$$

$$x = 3631.56$$

$$C = 2\pi R = 2\pi(3631.56) \approx 22,800 \text{ mi}$$

74. $d = \frac{C}{\pi}$

$$= \frac{22,800}{\pi} \approx 7260 \text{ mi}$$

Chapter 13 continued

75. $\cos 104.5^\circ = \frac{x}{96}$

$x = -24.03$

$96 = \sqrt{(0 + .24)^2 + (y)^2}$

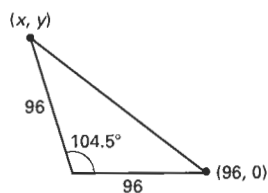
$96 = \sqrt{24^2 + y^2}$

$9216 = 576 + y^2$

$8640 = y^2$

$93 = y$

$(-24, 93)$



76. $(-24, 93), (96, 0)$

$d = \sqrt{(96 + 24)^2 + (0 - 93)^2}$

$= \sqrt{120^2 + 8649}$

$= \sqrt{14400 + 8649}$

$= \sqrt{23049}$

$= 151.8$ picometers

77. A

$\sec\left(\frac{40\pi}{3}\right) = -2$

78. C

$d = \frac{V^2}{32} \sin 2(40^\circ) = \frac{70^2}{32} \sin 80^\circ = \frac{4900}{32}(0.9848)$

$= 150.8$

79. $x = -1, y = 2, r = \sqrt{1 + 4} = \sqrt{5}$

$\tan \theta = -2, \theta = 116.565$

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

$\cot \theta = -\frac{1}{2}, \csc \theta = \frac{\sqrt{5}}{2}$

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

80. $\cos \theta = -0.64$

$\theta = 230.21$

$\sin \theta = -0.7684$

$\tan \theta = 1.2007$

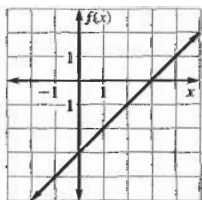
$\csc \theta = -1.3014$

$\sec \theta = -1.5625$

$\cot \theta = 0.8329$

81. $f(x) = x - 3$

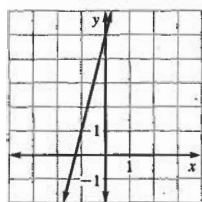
; yes



x	3	2	5
y	0	-1	2

82. $f(x) = 4x + 5$

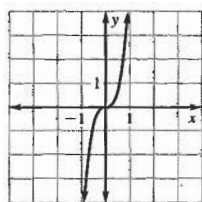
x	0	1	-1
y	5	9	1



yes

84. $f(x) = 5x^3$

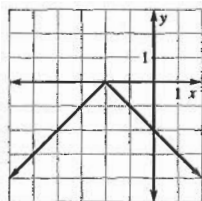
x	1	-1	0
y	5	-5	0



yes

86. $f(x) = -|x + 2|$

x	0	1	-1	2	-2	-4
y	-2	-3	-1	-4	0	-2



no

87. $\frac{1}{52}$ 88. $\frac{4}{52} + \frac{12}{52} = \frac{16}{52} = \frac{4}{13}$

89. $\frac{4}{52} + \frac{12}{52} = \frac{16}{52} = \frac{4}{13}$

90. $90^\circ + 62^\circ = 152^\circ$

$180^\circ - 152^\circ = 28^\circ$

$B = 28^\circ$

$\sin 28^\circ = \frac{5}{c}$

$\tan 28^\circ = \frac{5}{a}$

$0.46947 = \frac{5}{c}$

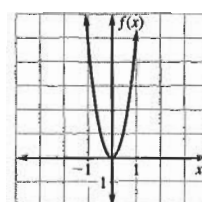
$0.53171 = \frac{5}{a}$

$10.65 = c$

$9.4036 = a$

83. $f(x) = 5x^2$

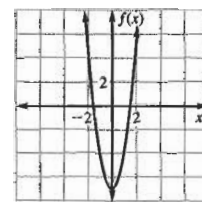
x	0	1	-1
y	0	5	5



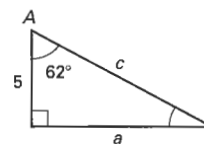
no

85. $f(x) = 3x^2 - 7$

x	0	1	-1
y	-7	-4	-4



no



Chapter 13 continued

91. $90^\circ + 20^\circ = 110^\circ$

$180^\circ - 110^\circ = 70^\circ$

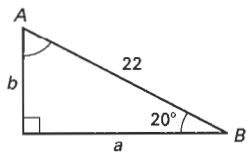
$A = 70^\circ$

$\sin 20^\circ = \frac{b}{22}$

$b = 7.52$

$\cos 20^\circ = \frac{a}{22}$

$a = 20.67$



92. $31^\circ + 90^\circ = 121^\circ$

$180^\circ - 121^\circ = 59^\circ$

$A = 59^\circ$

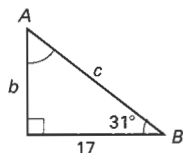
$\tan 31^\circ = \frac{b}{17}$

$b = 10.2$

$\cos 31^\circ = \frac{17}{c}$

$0.85717 = \frac{17}{c}$

$c = 19.8$



93. $50^\circ + 90^\circ = 140^\circ$

$180^\circ - 140^\circ = 40^\circ$

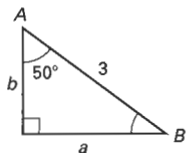
$B = 40^\circ$

$\sin 40^\circ = \frac{b}{3}$

$b = 1.9284$

$\cos 40^\circ = \frac{a}{3}$

$a = 2.2981$



94. $75^\circ + 90^\circ = 165^\circ$

$180^\circ - 165^\circ = 15^\circ$

$A = 15^\circ$

$\sin 75^\circ = \frac{34}{c}$

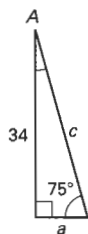
$0.96593 = \frac{34}{c}$

$c = 35.2$

$\tan 75^\circ = \frac{35}{a}$

$3.7321 = \frac{34}{a}$

$a = 9.11$



95. $83^\circ + 90^\circ = 173^\circ$

$180^\circ - 173^\circ = 7^\circ$

$B = 7^\circ$

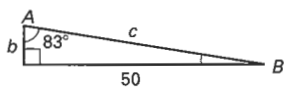
$\sin 83^\circ = \frac{50}{c}$

$0.99255 = \frac{50}{c}$

$c = 50.3753$

$\tan 7^\circ = \frac{b}{50}$

$b = 6.14$



Lesson 13.4

Developing Concepts Activity 13.4 (p. 791)

Exploring the Concept

1.

x	-4	-3	-2	-1	0
$f(x) = x^2$	16	9	4	1	0

x	1	2	3	4
$f(x) = x^2$	1	4	9	16

2. $f(x) = x^2$ cannot have an inverse because as can be seen in the chart more than 1 value for x gives the same value for y . Example: $x = -4, y = 16, x = 4, y = 16$

3. Let $x = 0$. By restricting x to greater than or equal to 0, it will give the usual square root function as the inverse.

4.

θ	$-\pi$	$-\frac{3\pi}{4}$	$-\frac{\pi}{2}$	$-\frac{\pi}{4}$	0
$f(x) = \sin \theta$	0	$-\frac{\sqrt{2}}{2}$	-1	$-\frac{\sqrt{2}}{2}$	0
$f(x) = \cos \theta$	-1	$-\frac{\sqrt{2}}{2}$	0	$\frac{\sqrt{2}}{2}$	1
$f(x) = \tan \theta$	0	1	undef.	-1	0

θ	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π
$f(x) = \sin \theta$	$\frac{\sqrt{2}}{2}$	1	$\frac{\sqrt{2}}{2}$	0
$f(x) = \cos \theta$	$\frac{\sqrt{2}}{2}$	0	$-\frac{\sqrt{2}}{2}$	-1
$f(x) = \tan \theta$	1	undef.	-1	0

5. $f(x) = \sin x$ cannot have an inverse in this domain since more than one value of θ gives the same y value. Example: Both 0 and π give 0.

6. No; more than one value of θ maps to the same y value. Both $-\pi$ and π map to -1.

7. No; more than one value of θ maps to the same y -value. Example: Both $-\pi$ and π map to 0.

Drawing Conclusions

- Let $-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$. This domain gives no repeated values for $\sin \theta$, and the domain cannot be extended any further and still allow an inverse.
- Let $0 \leq \theta \leq \pi$. This domain gives no repeated values for $\cos \theta$, and a longer interval cannot be used or the function will not be invertible.

Chapter 13 continued

3. Let $0 < \theta \leq \pi$. This domain gives no repeated values for $\tan \theta$, and a longer interval cannot be used or the function will not be invertible.
4. No. There are other choices for domains that would give a different value for y for each x given.

13.4 Guided Practice (p. 795)

- inverse
- Some of the domain values map to the same y value. For example, $-\frac{\pi}{4}$ and $\frac{\pi}{4}$ both are mapped to $\frac{\sqrt{2}}{2}$.
- The number 3 is in the range of $\tan \theta$, but not in the range of $\cos \theta$. The domain of \tan^{-1} is $-\infty < x < \infty$, but the domain of \cos^{-1} is $-1 \leq x \leq 1$.
- The angle she obtained is in Quad II, not Quadrant III. She should have added the opposite to the angle to 180° , obtaining 198.8° .

5. $\tan^{-1} \sqrt{3} = \frac{\pi}{3}$ or 60° 6. $\cos^{-1} \frac{\sqrt{2}}{2} = \frac{\pi}{4}$ or 45°

7. $\sin^{-1} \frac{1}{2} = \frac{\pi}{6}$ or 30° 8. $\cos^{-1} \left(-\frac{1}{2}\right) = \frac{2\pi}{3}$ or 120°

9. 1.32; 75.6° 10. 2.79; 160° 11. 1.22; 70.1°

12. $-0.412, -23.6^\circ$

13. $\sin^{-1}(-0.35) \approx -20^\circ$ 14. $\tan^{-1}(2.4) \approx 67.38^\circ$

$180^\circ + 20^\circ = 200^\circ$ $180^\circ + 67.38^\circ = 247^\circ$

15. $\cos^{-1}(0.43) \approx 64.5^\circ$ 16. $\sin^{-1}(0.8) \approx 53.13^\circ$

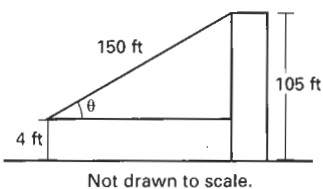
$360^\circ - 64.5^\circ = 295^\circ$ $180^\circ - 53.13^\circ = 127^\circ$

17. $\sin \theta = \frac{101}{150}$

$\sin \theta = 0.67\bar{3}$

$\sin^{-1}(0.67\bar{3}) \approx 42.3^\circ$

$\theta \approx 42.3^\circ$



13.4 Practice and Applications (p. 795)

18. $\sin^{-1} \frac{\sqrt{2}}{2} = \frac{\pi}{4}$ or 45° 19. $\cos^{-1} \frac{1}{2} = \frac{\pi}{3}$ or 60°

20. $\tan^{-1} 1 = \frac{\pi}{4}$ or 45° 21. $\sin^{-1} 0 = 0$ or 0°

22. $\cos^{-1}(-1) = \pi$ or 180° 23. $\sin^{-1}(-1) = -\frac{\pi}{2}$ or -90°

24. $\tan^{-1} \left(-\frac{\sqrt{3}}{3}\right) = -\frac{\pi}{6}$ or -30°

25. $\cos^{-1} \left(-\frac{\sqrt{3}}{2}\right) = \frac{5\pi}{6}$ or 150°

26. $\tan \theta = \frac{2}{4}$

$\tan^{-1}(0.5) \approx 26.6$

$\theta = 26.6^\circ$

28. $\sin \theta = \frac{4}{7}$

$\sin^{-1} \left(\frac{4}{7}\right) \approx 34.8$

$\theta \approx 34.8^\circ$

30. $\sin \theta = \frac{6}{10}$

$\sin^{-1} \left(\frac{6}{10}\right) \approx 36.9$

$\theta \approx 36.9^\circ$

27. $\cos \theta = \frac{2}{3}$

$\cos^{-1} \left(\frac{2}{3}\right) \approx 48.2$

$\theta = 48.2^\circ$

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

$\cos^{-1} \left(\frac{\sqrt{3}}{2}\right) = 30^\circ$

$\theta = 30^\circ$

$30^\circ + 90^\circ = 120^\circ$

31. $\tan \theta = \frac{3}{9}$

$\tan^{-1} \left(\frac{3}{9}\right) \approx 18.4^\circ$

$\theta \approx 18.4^\circ$

32. $\tan^{-1} 3.9 = 1.32; 75.6^\circ$ 33. $\cos^{-1} 0.24 = 1.33; 76.1^\circ$

34. $\cos^{-1} 0.34 = 1.22; 70.1^\circ$ 35. $\sin^{-1} 0.75 = 0.848; 48.6^\circ$

36. $\sin^{-1}(-0.4) = -0.412; -23.6^\circ$

37. $\cos^{-1}(-0.6) = 2.21; 127^\circ$

38. $\tan^{-1}(-0.2) = -0.197; -11.3^\circ$

39. $\tan^{-1} 2.25 = 1.15; 66^\circ$ 40. $\cos^{-1}(-0.8) = 2.50; 143^\circ$

41. $\sin^{-1} 0.99 = 1.43; 81.9^\circ$ 42. $\tan^{-1} 12 = 1.49; 85.2^\circ$

43. $\cos^{-1} 0.55 = 0.988; 56.6^\circ$

44. $\sin \theta = -0.35$ 45. $\tan \theta = 2.4$

$\sin^{-1}(-0.35) = -20.49$

$\tan^{-1}(2.4) = 67.4$

$180^\circ + 20^\circ = 200^\circ$

$180^\circ + 67.4^\circ = 247^\circ$

46. $\cos \theta = 0.43$

$\cos^{-1}(0.43) = 64.5^\circ$

$360^\circ - 64.5^\circ = 295^\circ$

47. $\sin \theta = 0.8$

$\sin^{-1}(0.8) = 53.1$

$180^\circ - 53.1^\circ = 127^\circ$

48. $\tan \theta = -2.1$

$\tan^{-1}(-2.1) = -64.5$

$180^\circ - 64.5^\circ = 115^\circ$

49. $\cos \theta = -0.72$

$\cos^{-1}(-0.72) \approx 136$

$180^\circ + 44^\circ = 224^\circ$

50. $\sin \theta = 0.2$

$\sin^{-1}(0.2) = 11.5$

$180^\circ - 11.5^\circ = 168^\circ$

51. $\tan \theta = 0.9$

$\tan^{-1}(0.9) = 42$

$180^\circ + 42^\circ = 222^\circ$

52. $\tan \theta = \frac{5}{10}$

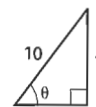
$\tan^{-1} \frac{5}{10} = 26.6$

$\theta = 26.6^\circ$

53. $\sin \theta = \frac{7}{10}$

$\sin^{-1} \left(\frac{7}{10}\right) = 44.4$

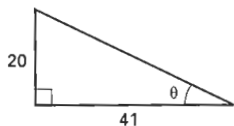
$\theta = 44.4^\circ$



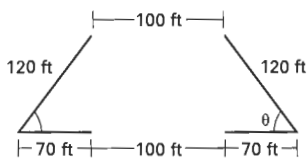
Chapter 13 continued

54. $\tan \theta = \frac{20}{41}$ 55. $\tan \theta = \frac{158}{225}$

$\tan^{-1}\left(\frac{20}{41}\right) = 26$ $\tan^{-1}\left(\frac{158}{225}\right) \approx 35.1$
 $\theta = 26^\circ$ $35.1 \times 2 = 70.2^\circ$



56. $\cos \theta = \frac{70}{120}$
 $\cos^{-1}\left(\frac{70}{120}\right) = 54.3$
 $\theta = 54.3^\circ$



57. $\frac{145 \text{ m}}{\text{hr}} \cdot \frac{1 \text{ hr}}{3600 \text{ sec}} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} = \frac{765,600}{3600 \text{ sec}} = 212.7 \text{ ft/sec}$

$\tan \theta = \frac{212.7}{100}$
 $\theta = \tan^{-1}(2.127)$

58. $y = 3x - 2$ Slope = 3

59. $\tan^{-1}(3) = 71.6$
 $\theta = 71.6^\circ$

60. Answers may vary; $\theta = \tan^{-1} m$

61. $\tan 58^\circ = m$, $y = 1.6x + 3$

62. $\tan 35^\circ = m$, $y = 0.7x - 2.8$

63. a. $\frac{\sin 60^\circ}{\sin \theta} = 1.341$ b. $\tan 40.2 = \frac{x}{2}$ $\tan 60 = \frac{y}{2}$

$\frac{0.866}{\sin \theta} = 1.341$ $x = 1.69$ $y = 3.46$

$\sin \theta = 0.6458$

$\theta = 40.2^\circ$

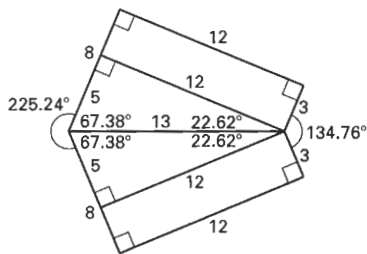
c. $3.46 - 1.69 = 1.77 \text{ ft}$

d. As you move closer to the shell d must get smaller and smaller. As you walk closer, the angles θ_1 and θ_2 will decrease, along with the distance y , until you are standing directly over the shell, at which time y (and so also d) will be zero.

64. $5^2 + b^2 = 13^2$

$b^2 = 144$

$b = 12$



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

$\theta = \tan^{-1}\frac{5}{12}$
 $\theta \approx 22.62^\circ$

$S = r\theta$
 $= 3\left(\frac{134.76\pi}{180}\right)$
 ≈ 7.05

$12 + 12 + 31.45 + 7.05 = 62.5$

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

$\theta = \tan^{-1}\frac{12}{5}$
 $\theta \approx 67.38^\circ$

$S = r\theta$
 $= 8\left(\frac{225.24\pi}{180}\right)$
 ≈ 31.45

13.4 Mixed Review (p. 798)

65. $\frac{6}{x} = \frac{7}{x+3}$

$6x + 18 = 7x$
 $18 = x$

66. $\frac{3}{x-3} = \frac{7}{x}$

$3x = 7x - 21$
 $-4x = -21$

$x = \frac{21}{4}$

67. $\frac{-1}{4+x} = \frac{6}{2x}$

$-2x = 24 + 6x$

$-8x = 24$

$x = -3$

68. $\frac{3}{x+3} + 7 = \frac{-4}{x+3}$

$\frac{7x+24}{x+3} = \frac{-4}{x+3}$

$-4x - 12 = 7x^2 + 21x + 24x + 72$

$-4x - 12 = 7x^2 + 45x + 72$

$-12 = 7x^2 + 49x + 72$

$0 = 7x^2 + 49x + 84$

$0 = 7(x^2 + 7x + 12)$

$0 = 7(x+4)(x+3)$

$x = -4$

69. $\frac{1}{x+2} = \frac{x}{2x+9}$

$2x + 9 = x^2 + 2x$

$0 = x^2 - 9$

$9 = x^2$

$-3, 3 = x$

Chapter 13 continued

$$70. \frac{3x}{x-2} = 2 + \frac{6}{x-2}$$

$$\frac{3x}{x-2} = \frac{2x-4+6}{x-2}$$

$$\frac{3x}{x-2} = \frac{2x+2}{x-2}$$

$$3x^2 - 6x = 2x^2 + 2x - 4x - 4$$

$$x^2 - 4x + 4 = 0$$

$$(x-2)(x-2) = 0$$

$$x = 2$$

No solution

$$71. \frac{6}{30} = \frac{1}{5} \quad 72. \frac{10}{30} = \frac{1}{3} \quad 73. \frac{15}{30} = \frac{1}{2} \quad 74. \frac{10}{30} = \frac{1}{3}$$

$$75. \frac{11}{30} \quad 76. \frac{7}{30} \quad 77. \sin 27^\circ = 0.4540$$

$$78. \sin \frac{23\pi}{8} = 0.3827 \quad 79. \cos 67^\circ = 0.3907$$

$$80. \sec \frac{53\pi}{9} = 1.0642 \quad 81. \tan 192^\circ = 0.2126$$

$$82. \csc 219^\circ = -1.5890$$

Quiz 2 (p. 798)

$$1. (-9, -16)$$

$$r = \sqrt{(-9)^2 + (-16)^2} = \sqrt{81 + 256} = \sqrt{337}$$

$$x = -9, y = -16, r = \sqrt{337}$$

$$\sin \theta = \frac{-16\sqrt{337}}{337}, \cos \theta = \frac{-9\sqrt{337}}{337}$$

$$\tan \theta = \frac{16}{9}, \csc \theta = \frac{\sqrt{337}}{-16}$$

$$\sec \theta = \frac{\sqrt{337}}{-9}, \cot \theta = \frac{9}{16}$$

$$2. (7, -2)$$

$$r = \sqrt{7^2 + (-2)^2} = \sqrt{49 + 4} = \sqrt{53}$$

$$x = 7, y = -2, r = \sqrt{53}$$

$$\sin \theta = \frac{-2\sqrt{53}}{53}, \cos \theta = \frac{7\sqrt{53}}{53}$$

$$\tan \theta = \frac{-2}{7}, \cot \theta = \frac{7}{-2}$$

$$\csc \theta = \frac{\sqrt{53}}{-2}, \sec \theta = \frac{\sqrt{53}}{7}$$

$$3. (-1, 5)$$

$$r = \sqrt{(-1)^2 + 5^2} = \sqrt{1 + 25} = \sqrt{26}$$

$$x = -1, y = 5, r = \sqrt{26}$$

$$\sin \theta = \frac{5\sqrt{26}}{26}, \cos \theta = \frac{-\sqrt{26}}{26}$$

$$\tan \theta = -5, \cot \theta = -\frac{1}{5}$$

$$\csc \theta = \frac{\sqrt{26}}{5}, \sec \theta = -\sqrt{26}$$

$$4. (6, -11)$$

$$r = \sqrt{6^2 + (-11)^2} = \sqrt{36 + 121} = \sqrt{157}$$

$$x = 6, y = -11, r = \sqrt{157}$$

$$\sin \theta = \frac{-11\sqrt{157}}{157}, \cos \theta = \frac{6\sqrt{157}}{157}$$

$$\tan \theta = \frac{-11}{6}, \cot \theta = \frac{6}{-11}$$

$$\csc \theta = \frac{\sqrt{157}}{-11}, \sec \theta = \frac{\sqrt{157}}{6}$$

$$5. (3, 6)$$

$$r = \sqrt{9 + 36} = \sqrt{45} = 3\sqrt{5}$$

$$x = 3, y = 6, r = 3\sqrt{5}$$

$$\sin \theta = \frac{2\sqrt{5}}{5}, \cos \theta = \frac{\sqrt{5}}{5}$$

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

$$\csc \theta = \frac{\sqrt{5}}{2}, \sec \theta = \sqrt{5}$$

$$6. (-12, 3)$$

$$r = \sqrt{144 + 9} = \sqrt{153}$$

$$x = -12, y = 3, r = \sqrt{153}$$

$$\sin \theta = \frac{\sqrt{153}}{51}, \cos \theta = \frac{-4\sqrt{153}}{51}$$

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

$$\csc \theta = \frac{\sqrt{153}}{3}, \sec \theta = \frac{\sqrt{153}}{-12}$$

$$7. (9, -5)$$

$$r = \sqrt{81 + 25} = \sqrt{106}$$

$$x = 9, y = -5, r = \sqrt{106}$$

$$\sin \theta = \frac{-5\sqrt{106}}{106}, \cos \theta = \frac{9\sqrt{106}}{106}$$

$$\tan \theta = -\frac{5}{9}, \cot \theta = \frac{9}{-5}$$

$$\csc \theta = \frac{\sqrt{106}}{-5}, \sec \theta = \frac{\sqrt{106}}{9}$$

$$8. (-7, -8)$$

$$r = \sqrt{49 + 64} = \sqrt{113}$$

$$x = -7, y = -8, r = \sqrt{113}$$

$$\sin \theta = \frac{-8\sqrt{113}}{113}, \cos \theta = \frac{-7\sqrt{113}}{113}$$

$$\tan \theta = \frac{8}{7}, \cot \theta = \frac{7}{8}$$

$$\csc \theta = \frac{\sqrt{113}}{-8}, \sec \theta = \frac{\sqrt{113}}{-7}$$

Chapter 13 continued

9. $\sin(-135^\circ)$
 $\sin 45^\circ = -\frac{\sqrt{2}}{2}$
11. $\cos(-420^\circ) = \frac{1}{2}$ 12. $\tan\left(-\frac{2\pi}{3}\right) = \sqrt{3}$
13. $\sin \frac{5\pi}{3} = -\frac{\sqrt{3}}{2}$ 14. $\cos 870^\circ = -\frac{\sqrt{3}}{2}$
15. $\tan(-30^\circ) = -\frac{\sqrt{3}}{3}$ 16. $\sin \frac{23\pi}{6} = -\frac{1}{2}$
17. $\tan^{-1} 2.3$
 1.16; 66.5°
18. $\sin^{-1}(-0.6)$
 -0.644; -36.9°
19. $\cos^{-1} 0.95$
 0.318; 18.2°
20. $\sin^{-1} 0.23$
 0.232; 13.3°
21. $\tan^{-1}(-4)$
 -1.33; -76°
22. $\cos^{-1}(-0.8)$
 2.5; 143°
23. $\sin^{-1} 0.1$
 0.100; 5.74°
24. $\tan^{-1} 10$
 1.47; 84.3°
25. $\sin \theta = 0.25$
 $\sin^{-1} 0.25 \approx 14.5^\circ$
 $180^\circ - 14^\circ = 166^\circ$
26. $\cos \theta = 0.21$
 $\cos^{-1} 0.21 \approx 77.9^\circ$
 $360^\circ - 78^\circ = 282^\circ$
27. $\tan \theta = 7$
 $\tan^{-1} 7 \approx 82^\circ$
 $180^\circ + 82^\circ = 262^\circ$
28. $\sin \theta = -0.44$
 $\sin^{-1}(-0.44) \approx -26^\circ$
 $180^\circ + 26^\circ = 206^\circ$
29. $\cos \theta = -0.3$
 $\cos^{-1}(-0.3) \approx 107^\circ$
 $180^\circ + 73^\circ = 253^\circ$
30. $\tan \theta = -4.5$
 $\tan^{-1}(-4.5) \approx -77^\circ$
 $180^\circ - 77^\circ = 103^\circ$
31. $d = \frac{V^2}{32} \sin 2\theta = \frac{40^2}{32} \sin 2(55) = \frac{1600}{32} \sin 110 = 47$ ft

Lesson 13.5

13.5 Guided Practice (p. 803)

- The ambiguous case; because there may be no triangle, one triangle, or two triangles.
- B and C
- If $a < b \sin A$; if $a > b$ or $a = b \sin A$; if $b \sin A < a < b$.
- one triangle 5. no triangle 6. one triangle
- two triangles
- $A = 180^\circ - 110^\circ - 34^\circ$
 $A = 36^\circ$

$$\frac{a}{\sin 36^\circ} = \frac{14}{\sin 34^\circ} = \frac{c}{\sin 110^\circ}$$

$$\frac{a}{\sin 36^\circ} = \frac{14}{\sin 34^\circ}$$

$$0.5592a = 8.229$$

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$$a = 14.7$$

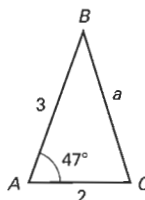
$$\frac{14}{\sin 34^\circ} = \frac{c}{\sin 110^\circ}$$

$$0.5592a = 13.1557$$

$$c = 23.5$$

9. $\frac{25}{\sin 95^\circ} = \frac{19}{\sin B}$
 $25 \sin B = 18.93$
 $\sin B = 0.7571$
 $B = 49.2^\circ$
 $A = 180^\circ - 49.2^\circ - 95^\circ$
 $= 35.8^\circ$
 $\frac{25}{\sin 95^\circ} = \frac{a}{\sin 35.8^\circ}$
 $14.624 = 0.9962a$
 $14.68 = a$

11. $A = \frac{1}{2}(3)(2) \sin 47^\circ$
 $= 2.19$ units²



10. $C = 180^\circ - 64^\circ - 70^\circ$
 $= 46^\circ$

$$\frac{5}{\sin 46^\circ} = \frac{a}{\sin 70^\circ}$$

$$4.6985 = 0.7193a$$

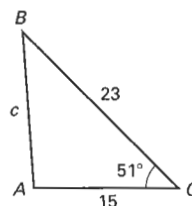
$$6.532 = a$$

$$\frac{5}{\sin 46^\circ} = \frac{b}{\sin 64^\circ}$$

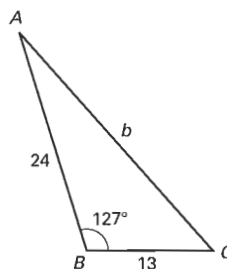
$$4.494 = 0.7193b$$

$$6.2477 = b$$

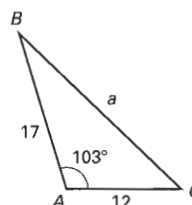
12. $A = \frac{1}{2}(23)(15) \sin 51^\circ$
 $= 134.06$ units²



13. $A = \frac{1}{2}(24)(13) \sin 127^\circ$
 $= 124.59$ units²



14. $A = \frac{1}{2}(17)(12) \sin 103^\circ$
 $= 99.39$ units²



15. $A = \frac{1}{2}(450)(620) \sin 100^\circ$

$$= 137,380.68$$
 yd²

$$137,380.68 \div 4840 = 28.38$$
 acres

$$28.38 \text{ acres} (2200) = \$62,445.76$$

13.5 Practice and Applications (pp. 803–806)

16. 1 triangle 17. no triangle 18. 1 triangle
 19. 2 triangles 20. no triangle 21. 1 triangle
 22. 2 triangles 23. no triangle