

CHAPTER 13

Think & Discuss (p. 767)

$$1. \frac{2}{\sqrt{3}} = \frac{65}{h}$$

$$2h = 65\sqrt{3}$$

$$2h = 112.58$$

$$h = 56.3 \text{ ft}$$

$$2. \quad 2x + w = 130$$

$$2(32.5) + w = 130$$

$$65 + w = 130$$

$$w = 65 \text{ ft}$$

$$\frac{2}{1} = \frac{65}{x}$$

$$2x = 65$$

$$x = 32.5$$

Skill Review (p. 768)

$$1. x^2 + 9^2 = 15^2$$

$$x^2 + 81 = 225$$

$$x^2 = 144$$

$$x = 12$$

$$3. 3^2 + 3^2 = x^2$$

$$9 + 9 = x^2$$

$$18 = x^2$$

$$x = \sqrt{18}$$

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

$$5. \sqrt{18} = \sqrt{9} \cdot \sqrt{2} = 3\sqrt{2}$$

$$6. \sqrt{200} = \sqrt{100} \cdot \sqrt{2} = 10\sqrt{2}$$

$$7. \frac{2}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{2\sqrt{2}}{2} = \sqrt{2}$$

$$8. \frac{2}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{2\sqrt{3}}{3}$$

$$9. \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2}$$

$$10. \quad \frac{3}{x} = \frac{6}{x-1}$$

$$3(x-1) = 6x$$

$$3x - 3 = 6x$$

$$-3 = 3x$$

$$-1 = x$$

$$11. \frac{4x}{5} = \frac{5}{x}$$

$$4x^2 = 25$$

$$x^2 = \frac{25}{4}$$

$$x = \sqrt{\frac{25}{4}}$$

$$x = \pm \frac{5}{2}$$

$$12. \quad \frac{7}{4} = \frac{x}{8}$$

$$56 = 4x$$

$$14 = x$$

$$13. \frac{x+3}{x} = \frac{7}{10}$$

$$7x = 10x + 30$$

$$-3x = 30$$

$$x = -10$$

Lesson 13.1

13.1 Guided Practice (p. 772)

- To find the measures of all unknown angles and sides
- No; all $30^\circ - 60^\circ - 90^\circ$ triangles are similar to one another, and you need to know the length of at least one side to find the others.
- sine and cosecant
- 30°

$$5. \quad 6^2 + 8^2 = x^2$$

$$36 + 64 = x^2$$

$$100 = x^2$$

$$10 = x$$

$$\sin \theta = \frac{6}{10} = \frac{3}{5}$$

$$\tan \theta = \frac{6}{8} = \frac{3}{4}$$

$$\sec \theta = \frac{10}{8} = \frac{5}{4}$$

$$\cos \theta = \frac{8}{10} = \frac{4}{5}$$

$$\csc \theta = \frac{10}{6} = \frac{5}{3}$$

$$\cot \theta = \frac{8}{6} = \frac{4}{3}$$

$$6. \quad 3^2 + x^2 = (3\sqrt{2})^2$$

$$9 + x^2 = 9(2)$$

$$x^2 = 9$$

$$x = 3$$

$$\sin \theta = \frac{3}{3\sqrt{2}} = \frac{1}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{2}}{2}$$

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

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

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

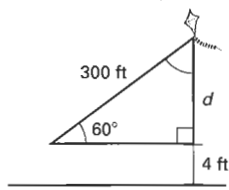
$$\sec \theta = \frac{3\sqrt{2}}{3} = \sqrt{2}$$

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

Chapter 13 continued

7. $6^2 + x^2 = 9^2$
 $36 + x^2 = 81$
 $x^2 = 45$
 $x = 3\sqrt{5}$
 $\sin \theta = \frac{3\sqrt{5}}{9} = \frac{\sqrt{5}}{3}$
 $\cos \theta = \frac{6}{9} = \frac{2}{3}$
 $\tan \theta = \frac{3\sqrt{5}}{6} = \frac{\sqrt{5}}{2}$
 $\csc \theta = \frac{9}{3\sqrt{5}} = \frac{3}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{3\sqrt{5}}{5}$
 $\sec \theta = \frac{9}{6} = \frac{3}{2}$
 $\cot \theta = \frac{6}{3\sqrt{5}} = \frac{2}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{2\sqrt{5}}{5}$
8. $20^\circ + 90^\circ = 110^\circ$ 9. $75^\circ + 90^\circ = 165^\circ$
 $180^\circ - 110^\circ = 70^\circ = B$ $180^\circ - 165^\circ = 15^\circ$
 $\sin A = \frac{\text{opp}}{\text{hyp}}$ $B = 15^\circ$
 $\sin 20^\circ = \frac{12}{c}$ $\sin 75^\circ = \frac{a}{20}$
 $0.3420 = \frac{12}{c}$ $0.9659 = \frac{a}{20}$
 $c = 35.09$ $19.32 = a$
 $b^2 + 12^2 = 35.1^2$ $19.32^2 + b^2 = 20^2$
 $b^2 + 144 = 1232.01$ $373.26 + b^2 = 400$
 $b^2 = 1088.01$ $b^2 = 26.74$
 $b = 32.98$ $b = 5.17$
10. $40^\circ + 90^\circ = 130^\circ$ 11. $62^\circ + 90^\circ = 152^\circ$
 $180^\circ - 130^\circ = 50^\circ$ $180^\circ - 152^\circ = 28^\circ$
 $A = 50^\circ$ $B = 28^\circ$
 $\sin 50^\circ = \frac{a}{5}$ $\cos 62^\circ = \frac{30}{c}$
 $0.766 = \frac{a}{5}$ $0.4695 = \frac{30}{c}$
 $3.83 = a$ $c = 63.90$
 $3.83^2 + b^2 = 5^2$ $30^2 + a^2 = 63.9^2$
 $14.67 + b^2 = 25$ $900 + a^2 = 4083.21$
 $b^2 = 10.33$ $a^2 = 3183.21$
 $b = 3.21$ $a = 56.42$

12. $63^\circ + 90^\circ = 153^\circ$ 13. $15^\circ + 90^\circ = 105^\circ$
 $180^\circ - 153^\circ = 27^\circ$ $180^\circ - 105^\circ = 75^\circ$
 $A = 27^\circ$ $A = 75^\circ$
 $\sin 27^\circ = \frac{15}{c}$ $\cos 75^\circ = \frac{42}{c}$
 $0.4540 = \frac{15}{c}$ $0.2588 = \frac{42}{c}$
 $c = 33.04$ $c = 162.29$
 $15^2 + b^2 = 33.04^2$ $42^2 + a^2 = 162.29^2$
 $225 + b^2 = 1091.64$ $1764 + a^2 = 26,338.04$
 $b^2 = 866.64$ $a^2 = 24,574.04$
 $b = 29.44$ $a = 156.76$

14.  $\sin 60^\circ = \frac{d}{300}$
 $0.866 = \frac{d}{300}$
 $259.81 = d$
 Height = $4 + 259.81 \approx 264$ ft

13.1 Practice and Applications (pp. 772–774)

15. $C = \sqrt{5^2 + 10^2} = \sqrt{125} = 5\sqrt{5}$
 $\sin \theta = \frac{5}{5\sqrt{5}} = \frac{1}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{5}}{5}$
 $\cos \theta = \frac{10}{5\sqrt{5}} = \frac{2}{\sqrt{5}} \cdot \frac{\sqrt{5}}{\sqrt{5}} = \frac{2\sqrt{5}}{5}$
 $\tan \theta = \frac{5}{10} = \frac{1}{2}$
 $\csc \theta = \frac{5\sqrt{5}}{5} = \sqrt{5}$
 $\sec \theta = \frac{5\sqrt{5}}{10} = \frac{\sqrt{5}}{2}$
 $\cot \theta = \frac{10}{5} = 2$
16. $C = \sqrt{9^2 + 12^2} = \sqrt{225} = 15$
 $\sin \theta = \frac{12}{15} = \frac{4}{5}$
 $\cos \theta = \frac{9}{15} = \frac{3}{5}$
 $\tan \theta = \frac{12}{9} = \frac{4}{3}$
 $\csc \theta = \frac{15}{12} = \frac{5}{4}$
 $\sec \theta = \frac{15}{9} = \frac{5}{3}$
 $\cot \theta = \frac{9}{12} = \frac{3}{4}$

Chapter 13 continued

17. $10^2 + b^2 = 18^2$

$$100 + b^2 = 324$$

$$b^2 = 224$$

$$b = \sqrt{16} - \sqrt{14}$$

$$b = 4\sqrt{14}$$

$$\sin \theta = \frac{4\sqrt{14}}{18} = \frac{2\sqrt{14}}{9}$$

$$\cos \theta = \frac{10}{18} = \frac{5}{9}$$

$$\tan \theta = \frac{4\sqrt{14}}{10} = \frac{2\sqrt{14}}{5}$$

$$\csc \theta = \frac{18}{4\sqrt{14}} = \frac{9}{2\sqrt{14}} \cdot \frac{\sqrt{14}}{\sqrt{14}} = \frac{9\sqrt{14}}{28}$$

$$\sec \theta = \frac{18}{10} = \frac{9}{5}$$

$$\cot \theta = \frac{10}{4\sqrt{14}} = \frac{5}{2\sqrt{14}} \cdot \frac{\sqrt{14}}{\sqrt{14}} = \frac{5\sqrt{14}}{28}$$

18. $4^2 + b^2 = 13^2$

$$16 + b^2 = 169$$

$$b^2 = 153$$

$$b = 3\sqrt{17}$$

$$\sin \theta = \frac{4}{13}$$

$$\cos \theta = \frac{3\sqrt{17}}{13}$$

$$\tan \theta = \frac{4}{3\sqrt{17}} \cdot \frac{\sqrt{17}}{\sqrt{17}} = \frac{4\sqrt{17}}{51}$$

$$\csc \theta = \frac{13}{4}$$

$$\sec \theta = \frac{13}{3\sqrt{17}} \cdot \frac{\sqrt{17}}{\sqrt{17}} = \frac{13\sqrt{17}}{51}$$

$$\cot \theta = \frac{3\sqrt{17}}{4}$$

19. $9^2 + b^2 = 25^2$

$$81 + b^2 = 625$$

$$b^2 = 544$$

$$b = \sqrt{16}\sqrt{34} = 4\sqrt{34}$$

$$\sin \theta = \frac{9}{25}$$

$$\cos \theta = \frac{4\sqrt{34}}{25}$$

$$\tan \theta = \frac{9}{4\sqrt{34}} \cdot \frac{\sqrt{34}}{\sqrt{34}} = \frac{9\sqrt{34}}{136}$$

—CONTINUED—

19. —CONTINUED—

$$\csc \theta = \frac{25}{9}$$

$$\sec \theta = \frac{25}{4\sqrt{34}} \cdot \frac{\sqrt{34}}{\sqrt{34}} = \frac{25\sqrt{34}}{136}$$

$$\cot \theta = \frac{4\sqrt{34}}{9}$$

20. $6^2 + b^2 = \sqrt{85}^2$

$$36 + b^2 = 85$$

$$b^2 = 49$$

$$b = 7$$

$$\sin \theta = \frac{6}{\sqrt{85}} \cdot \frac{\sqrt{85}}{\sqrt{85}} = \frac{6\sqrt{85}}{85}$$

$$\cos \theta = \frac{7}{\sqrt{85}} \cdot \frac{\sqrt{85}}{\sqrt{85}} = \frac{7\sqrt{85}}{85}$$

$$\tan \theta = \frac{6}{7}$$

$$\csc \theta = \frac{\sqrt{85}}{6}$$

$$\sec \theta = \frac{\sqrt{85}}{7}$$

$$\cot \theta = \frac{7}{6}$$

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

$$\cos \theta = \frac{12}{13}$$

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

$$\csc \theta = \frac{13}{5}$$

$$\sec \theta = \frac{13}{12}$$

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

22. $\sin 60^\circ = \frac{9}{x}$

$$\cos 60^\circ = \frac{y}{6\sqrt{3}}$$

$$\frac{\sqrt{3}}{2} = \frac{9}{x}$$

$$\frac{1}{2} = \frac{y}{6\sqrt{3}}$$

$$\sqrt{3}x = 18$$

$$2y = 6\sqrt{3}$$

$$x = \frac{18}{\sqrt{3}}$$

$$y = 3\sqrt{3}$$

$$x = \frac{18\sqrt{3}}{3}$$

$$x = 6\sqrt{3}$$

23. $\sin 45^\circ = \frac{y}{\sqrt{11}}$

$$\cos 45^\circ = \frac{x}{\sqrt{11}}$$

$$\frac{\sqrt{2}}{2} = \frac{y}{\sqrt{11}}$$

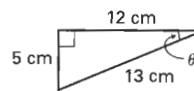
$$\frac{\sqrt{2}}{2} = \frac{x}{\sqrt{11}}$$

$$2y = \sqrt{22}$$

$$2x = \sqrt{22}$$

$$y = \frac{\sqrt{22}}{2}$$

$$x = \frac{\sqrt{22}}{2}$$



Chapter 13 continued

24. $\cos 30^\circ = \frac{14}{x}$

$$\frac{\sqrt{3}}{2} = \frac{14}{x}$$

$$\sqrt{3}x = 28$$

$$x = \frac{28}{\sqrt{3}} = \frac{28\sqrt{3}}{3}$$

$\tan 30^\circ = \frac{y}{14}$

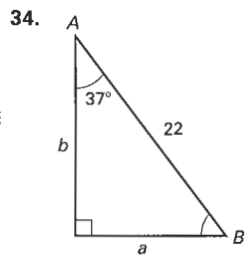
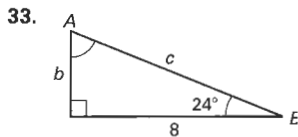
$$\frac{\sqrt{3}}{3} = \frac{y}{14}$$

$$3y = 14\sqrt{3}$$

$$y = \frac{14\sqrt{3}}{3}$$

25. 0.2419 26. 0.8572 27. 1.6643 28. 1.0864

29. 1.0154 30. 1.3764 31. 9.5668 32. 5.1446



$$90^\circ + 24^\circ = 114^\circ$$

$$180^\circ - 114^\circ = 66^\circ$$

$$A = 66^\circ$$

$$\cos 24^\circ = \frac{8}{c}$$

$$0.9135 = \frac{8}{c}$$

$$c = 8.76$$

$$8^2 + b^2 = 8.76^2$$

$$64 + b^2 = 76.74$$

$$b^2 = 12.74$$

$$b = 3.57$$

$$90^\circ + 37^\circ = 127^\circ$$

$$180^\circ - 127^\circ = 53^\circ$$

$$B = 53^\circ$$

$$\sin 53^\circ = \frac{b}{22}$$

$$0.7986 = \frac{b}{22}$$

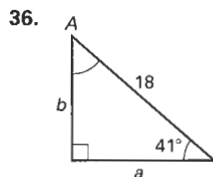
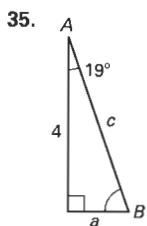
$$17.57 = b$$

$$17.57^2 + a^2 = 22^2$$

$$308.70 + a^2 = 484$$

$$a^2 = 175.3$$

$$a = 13.24$$



$$90^\circ + 19^\circ = 109^\circ$$

$$180^\circ - 109^\circ = 71^\circ$$

$$B = 71^\circ$$

$$\cos 19^\circ = \frac{4}{c}$$

$$0.9455 = \frac{4}{c}$$

$$c = 4.23$$

$$4^2 + a^2 = 4.23^2$$

$$16 + a^2 = 17.89$$

$$a^2 = 1.893$$

$$a = 1.38$$

$$41^\circ + 90^\circ = 131^\circ$$

$$180^\circ - 131^\circ = 49^\circ$$

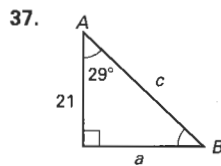
$$A = 49^\circ$$

$$\cos 41^\circ = \frac{a}{18}$$

$$a = 13.58$$

$$\sin 41^\circ = \frac{b}{18}$$

$$b = 11.81$$



$$90^\circ + 29^\circ = 119^\circ$$

$$180^\circ - 119^\circ = 61^\circ$$

$$B = 61^\circ$$

$$\sin 61^\circ = \frac{21}{c}$$

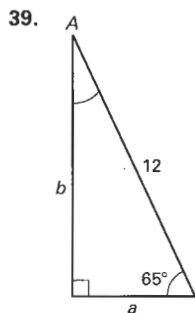
$$0.8746 = \frac{21}{c}$$

$$c = 24.01$$

$$\cos 61^\circ = \frac{a}{24.01}$$

$$0.4848 = \frac{a}{24.01}$$

$$11.64 = a$$



$$90^\circ + 65^\circ = 155^\circ$$

$$180^\circ - 155^\circ = 25^\circ$$

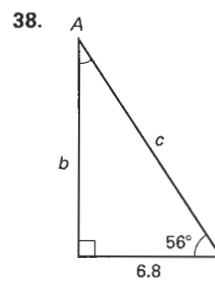
$$A = 25^\circ$$

$$\sin 65^\circ = \frac{b}{12}$$

$$b = 10.88$$

$$\cos 65^\circ = \frac{a}{12}$$

$$a = 5.07$$



$$56^\circ + 90^\circ = 146^\circ$$

$$180^\circ - 146^\circ = 34^\circ$$

$$A = 34^\circ$$

$$\cos 56^\circ = \frac{6.8}{c}$$

$$0.5592 = \frac{6.8}{c}$$

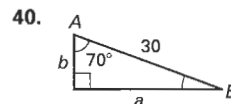
$$c = 12.16$$

$$6.8^2 + b^2 = 12.16^2$$

$$46.24 + b^2 = 147.87$$

$$b^2 = 101.63$$

$$b = 10.08$$



$$70^\circ + 90^\circ = 160^\circ$$

$$180^\circ - 160^\circ = 20^\circ$$

$$B = 20^\circ$$

$$\sin 20^\circ = \frac{b}{30}$$

$$b = 10.26$$

$$\cos 20^\circ = \frac{a}{30}$$

$$a = 28.19$$

Chapter 13 continued

41. $A = \frac{1}{2}bh = \frac{1}{2}(8)(4\sqrt{3})$

$A = 16\sqrt{3}$

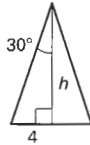
Area of hexagon = $16\sqrt{3} \times 6 = 96\sqrt{3}$ units²

$\tan 30^\circ = \frac{4}{h}$

$\frac{\sqrt{3}}{3} = \frac{4}{h}$

$\sqrt{3}h = 12$

$h = \frac{12}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{12\sqrt{3}}{3} = 4\sqrt{3}$



42. $A = \frac{1}{2}bh$

$= \frac{1}{2}(10)(12.07)$

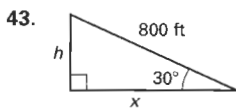
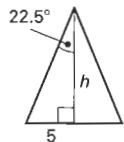
$= 60.36$

$\tan 22.5^\circ = \frac{5}{h}$

$0.4142 = \frac{5}{h}$

$h = 12.07$

Area of octagon = $60.36(8) = 482.9$ units²



44. $\frac{320}{1} = \frac{800}{N}$

$320N = 800$

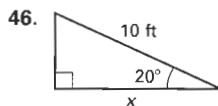
$N = 2.5$

$400 \div 2.5 = 160$ ft/min

$\sin 30^\circ = \frac{h}{800}$

$0.5 = \frac{h}{800}$

$400 = h$



$\sin 25.2^\circ = \frac{1808}{x}$

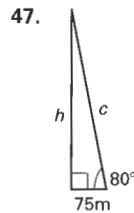
$\cos 20^\circ = \frac{x}{10}$

$0.4258 = \frac{1808}{x}$

$0.9397 = \frac{x}{10}$

$x = 4246$ ft

9.4 ft = x



$\tan 80^\circ = \frac{h}{75}$

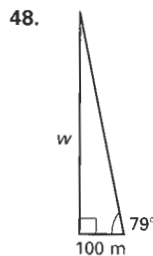
$5.67 = \frac{h}{75}$

425.35 m = h

$\cos 80^\circ = \frac{75}{c}$

$0.1736 = \frac{75}{c}$

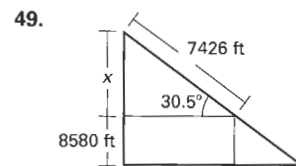
$c = 432$ m



$\tan 79^\circ = \frac{w}{100}$

$5.14 = \frac{w}{100}$

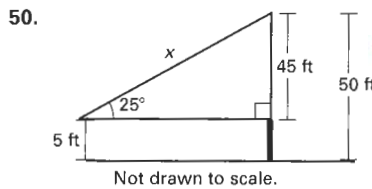
$w = 514.46$ m



$\sin 30.5^\circ = \frac{x}{7426}$

$3768.98 = x$

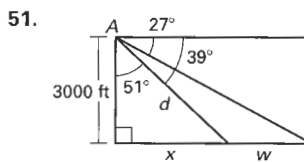
Height = $3768.98 + 8580$
 $= 12,348.98$ ft



$\sin 25^\circ = \frac{45}{x}$

$0.4226 = \frac{45}{x}$

$x = 106.48$ ft



$90 - 39 = 51^\circ$

a. $\cos 51^\circ = \frac{3000}{d}$

b. $\tan 51^\circ = \frac{x}{3000}$

$0.6293 = \frac{3000}{d}$

$x = 3704.69$ ft

4767.20 ft = d

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

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

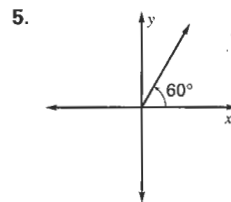
3. About 12,600 miles. Columbus's estimation of the radius of Earth at the equator was about 1100 miles short and the distance west nearly 10,000 miles short. The latitude he used for the Canary Islands was about 5° off, and for Japan was several more degrees off.

Lesson 13.2

13.2 Guided Practice (p. 780)

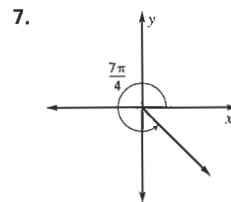
- A radian is a unit of angle measure equal to the angle that intercepts an arc of length r units in a circle of radius r .
- To find the area of a sector with this formula, you must use radian measure for the angle. The correct value is about 5.45 in.^2 .
- If the sign is positive, the terminal side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

4. $r\pi$



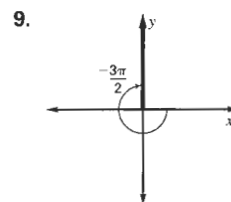
$$60 + 360 = 420^\circ$$

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



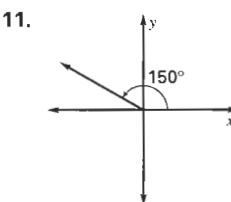
$$\frac{7\pi}{4} + 2\pi = \frac{15\pi}{4}$$

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



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

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



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

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

6. 

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

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

8. 

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

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

10. 

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

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

12. 

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

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