# Chapter 2

## Acute Angles and Right Triangles

### Section 2.1: Trigonometric Functions of Acute Angles

**1.** $\frac{21}{29}$; $\frac{20}{29}$; $\frac{21}{20}$

**2.** $\frac{45}{53}$; $\frac{28}{53}$; $\frac{45}{28}$

**3.** $\frac{n}{p}$; $\frac{m}{p}$; $\frac{n}{m}$

**4.** $\frac{k}{z}$; $\frac{y}{z}$; $\frac{k}{y}$

For Exercises 5–10, refer to the Function Values of Special Angles chart on page 54 of the text.

**5.** C  **6.** H

**7.** B  **8.** G

**9.** E  **10.** A

**11.** $c = 13$; $\frac{12}{13}$; $\frac{5}{13}$; $\frac{12}{5}$ $\frac{5}{12}$; $\frac{13}{5}$; $\frac{13}{12}$

**12.** $c = \sqrt{34}$; $\frac{5\sqrt{34}}{34}$; $\frac{3\sqrt{34}}{34}$; $\frac{5}{3}$; $\frac{3}{5}$; $\frac{\sqrt{34}}{3}$; $\frac{\sqrt{34}}{5}$

**13.** $b = \sqrt{13}$; $\frac{\sqrt{13}}{7}$; $\frac{6}{7}$; $\frac{\sqrt{13}}{6}$ $\frac{6\sqrt{13}}{13}$; $\frac{7}{6}$; $\frac{7\sqrt{13}}{13}$

**14.** $a = \sqrt{95}$; $\frac{7}{12}$; $\frac{\sqrt{95}}{12}$; $\frac{7\sqrt{95}}{95}$;
$\frac{\sqrt{95}}{7}$; $\frac{12\sqrt{95}}{95}$; $\frac{12}{7}$

**15.** $b = 4$; $\frac{4}{5}$; $\frac{3}{5}$; $\frac{4}{3}$ $\frac{3}{4}$; $\frac{5}{3}$; $\frac{5}{4}$

**16.** $\sqrt{57} = a$; $\frac{8}{11}$; $\frac{\sqrt{57}}{11}$; $\frac{8\sqrt{57}}{57}$;
$\frac{\sqrt{57}}{8}$; $\frac{11\sqrt{57}}{57}$; $\frac{11}{8}$

**17.** $\sin\theta = \cos(90° - \theta)$; $\cos\theta = \sin(90° - \theta)$;
$\tan\theta = \cot(90° - \theta)$; $\cot\theta = \tan(90° - \theta)$;
$\sec\theta = \csc(90° - \theta)$; $\csc\theta = \sec(90° - \theta)$

**18.** $\tan 17°$

**19.** $\csc 51°$

**20.** $\cos 63°$

**21.** $\csc(75° - \theta)$

**22.** $\sin(70° - \alpha)$

**23.** $\tan(100° - \theta)$

**24.** $\cot 64.6°$

**25.** $\cos 51.3°$

**26.** They are always the same.

For exercises 27–36, if the functions in the equations are cofunctions, then the equations are true if the sum of the angles is 90º.

**27.** 40°

**28.** 30°

**29.** 20°

**30.** 20°

**31.** 12°

**32.** 12°

**33.** 35°

**34.** 15°

**35.** 18°

**36.** 35°

**37.** true.

**38.** true.

**39.** false.

**40.** false.

**41.** true.

**42.** false.

**43.** true.

**44.** false.

**45.** $\frac{\sqrt{3}}{3}$ **46.** $\sqrt{3}$

**47.** $\frac{1}{2}$

**48.** $\frac{\sqrt{3}}{2}$

**49.** $\frac{2\sqrt{3}}{3}$

**50.** 2

**51.** $\sqrt{2}$

**52.** $\sqrt{2}$

**53.** $\frac{\sqrt{2}}{2}$

**54.** 1

**55.** 1

**56.** $\frac{\sqrt{2}}{2}$

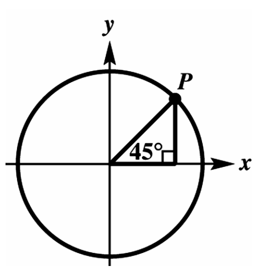
**57.** $\frac{\sqrt{3}}{2}$

**58.** $\frac{1}{2}$

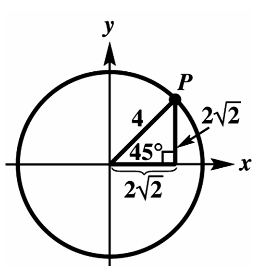
**59.** $\sqrt{3}$

**60.** $\frac{2\sqrt{3}}{3}$

**61.**




**62.**




**63.** The legs; $\left(2\sqrt{2}, 2\sqrt{2}\right)$.

**64.** $\left(1, \sqrt{3}\right)$.

**65.** sin $x$; tan $x$.

**66.** cos $x$; csc $x$.

**67.** 60°

**68.** .7071067812 is a rational approximation for the exact value $\frac{\sqrt{2}}{2}$ (an irrational value).

**69.** $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$.; 45°.

**70.** $y = \sqrt{3}x.$

**71.** $y = \frac{\sqrt{3}}{3}x.$

**72.** 30°

**73.** 60°

**74.** **(a)** 45º.
**(b)** $\sqrt{2}k$ .
**(c)** $\sqrt{2}$

**75.** **(a)** 60°
**(b)** $k$
**(c)** $\sqrt{3}k$
**(d)** 2; $\sqrt{3}$ ; 30º; 60º

**76.** $a = 12$; $b = 12\sqrt{3}$ **;** $d = 12\sqrt{3}$ and $c = 12\sqrt{6}$

**77.** $y = \frac{9}{2}$; $x = \frac{9\sqrt{3}}{2}$; $z = \frac{3\sqrt{3}}{2}$; $w = 3\sqrt{3}$

**78.** $m = \frac{7\sqrt{3}}{3}$ $a = \frac{14\sqrt{3}}{3}$ **;** $n = \frac{14\sqrt{3}}{3}$ ; $q = \frac{14\sqrt{6}}{3}$.

**79.** $p = 15$; $r = 15\sqrt{2}$; $q = 5\sqrt{6}$ ; $t = 10\sqrt{6}$

**80.** $A = \frac{s^2\sqrt{3}}{4}$

**81.** $A = \frac{s^2}{2}$

**82.** Yes

**83.** Answers will vary.

## Section 2.2: Trigonometric Functions of Non-Acute Angles

1. C;
2. F
3. A
4. B
5. D
6. B
7. 2 is a good choice for $r$ because in a $30° - 60°$ right triangle, the hypotenuse is twice the length of the shorter side (the side opposite to the $30°$ angle). By choosing 2, one avoids introducing a fraction (or decimal) when determining the length of the shorter side. Choosing any even positive integer for $r$ would have this result; however, 2 is the most convenient value.

**8.–9.** Answers will vary.

10. $\frac{\sqrt{3}}{3}$; $\sqrt{3}$
11. $\frac{\sqrt{2}}{2}$; $\frac{\sqrt{2}}{2}$; $\sqrt{2}$; $\sqrt{2}$
12. $\frac{\sqrt{3}}{2}$; $\frac{\sqrt{3}}{3}$; $\frac{2\sqrt{3}}{3}$
13. $-\frac{1}{2}$; $-\frac{\sqrt{3}}{3}$; $-2$
14. $-1$; $-1$
15. $\frac{1}{2}$; $-\sqrt{3}$; $-\frac{2\sqrt{3}}{3}$
16. $-\frac{\sqrt{3}}{2}$; $-\frac{2\sqrt{3}}{3}$
17. $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; $-\frac{2\sqrt{3}}{3}$
18. $-\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $-\sqrt{3}$; $-\frac{\sqrt{3}}{3}$; 2; $-\frac{2\sqrt{3}}{3}$
19. $-\frac{\sqrt{2}}{2}$; $\frac{\sqrt{2}}{2}$; $-1$; $-1$; $\sqrt{2}$; $-\sqrt{2}$
20. $\frac{\sqrt{2}}{2}$; $\frac{\sqrt{2}}{2}$; 1; 1; $\sqrt{2}$; $\sqrt{2}$
21. $\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; 2; $\frac{2\sqrt{3}}{3}$
22. $\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; 2; $\frac{2\sqrt{3}}{3}$
23. $\frac{\sqrt{3}}{2}$; $-\frac{1}{2}$; $-\sqrt{3}$; $-\frac{\sqrt{3}}{3}$; $-2$; $\frac{2\sqrt{3}}{3}$
24. $\frac{\sqrt{2}}{2}$; $-\frac{\sqrt{2}}{2}$; $-1$; $-1$; $-\sqrt{2}$; $\sqrt{2}$
25. $-\frac{1}{2}$; $-\frac{\sqrt{3}}{2}$; $\frac{\sqrt{3}}{3}$; $\sqrt{3}$; $-\frac{2\sqrt{3}}{3}$; $-2$
26. $\frac{1}{2}$; $\frac{\sqrt{3}}{2}$; $\frac{\sqrt{3}}{3}$; $\sqrt{3}$; $\frac{2\sqrt{3}}{3}$; 2
27. $-\frac{\sqrt{2}}{2}$; $-\frac{\sqrt{2}}{2}$; 1; 1; $-\sqrt{2}$; $-\sqrt{2}$
28. $\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; 2; $\frac{2\sqrt{3}}{3}$
29. $\frac{1}{2}$; $-\frac{\sqrt{3}}{2}$; $-\frac{\sqrt{3}}{3}$; $-\sqrt{3}$; $-\frac{2\sqrt{3}}{3}$; 2
30. $-\frac{1}{2}$; $\frac{\sqrt{3}}{2}$; $-\frac{\sqrt{3}}{3}$; $-\sqrt{3}$; $\frac{2\sqrt{3}}{3}$; $-2$
31. $-\frac{1}{2}$; $-\frac{\sqrt{3}}{2}$; $\frac{\sqrt{3}}{3}$; $\sqrt{3}$; $-\frac{2\sqrt{3}}{3}$; $-2$
32. $\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; 2; $\frac{2\sqrt{3}}{3}$
33. $\frac{1}{2}$; $-\frac{\sqrt{3}}{2}$; $-\frac{\sqrt{3}}{3}$; $-\sqrt{3}$; $-\frac{2\sqrt{3}}{3}$; 2
34. $-\frac{\sqrt{2}}{2}$; $-\frac{\sqrt{2}}{2}$; 1; 1; $-\sqrt{2}$; $-\sqrt{2}$
35. $-\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $-\sqrt{3}$; $-\frac{\sqrt{3}}{3}$; 2; $-\frac{2\sqrt{3}}{3}$
36. $-\frac{\sqrt{2}}{2}$
37. $-\frac{\sqrt{3}}{2}$
38. $\sqrt{3}$
39. $\frac{\sqrt{3}}{2}$
40. $-\sqrt{2}$ .
41. $-\sqrt{2}$
42. $-\frac{\sqrt{3}}{3}$ .

**43.** $-1$ **44.** $\frac{1+\sqrt{3}}{2} \neq 1$, false

**45.** true

**46.** true.

**47.** $\frac{1}{2} \neq \sqrt{3}$, false

**48.** $\frac{\sqrt{3}}{2} \neq 0$, false

**49.** true

**50.** true

**51.** true

**52.** true.

**53.** $0 \neq \frac{\sqrt{3}+1}{2}$, false

**54.** $\left(-5\sqrt{2}, -5\sqrt{2}\right)$

**55.** $\left(-3\sqrt{3}, 3\right)$

**56.** Yes

**57.** No

**58.** positive

**59.** positive

**60.** negative

**61.** positive

**62.** negative

**63.** negative

**64.** $\theta$ and $\theta + n \cdot 360°$ are coterminal angles, so the sine of each of these will result in the same value.

**65.** $\theta$ and $\theta + n \cdot 360°$ are coterminal angles, so the cosine of each of these will result in the same value.

**66.** –.4

**67.** sin 115°

**68.** 135° ; 315°

**69.** 45°; 225°

**70.** **(a)** Approximately 550 ft

**(b)** Approximately 369 ft

**(c)** Answers will vary.

**71.** 30°; 150°

**72.** 30°; 330°

**73.** 120°; 300°

**74.** 135°; 225°

**75.** 45°; 315°

**76.** 120°; 300°

**77.** 210°; , 330° .

**78.** 240° ; 300° .

**79.** 30° ; 210° .

**80.** 120°; 240°

**81.** 225° 315°

**82.** 135° ; 315°

## Section 2.3: Finding Trigonometric Function Values Using a Calculator

**1.** sin

**2.** approximate

**3.** reciprocal; reciprocal

**4.** before; after

In Exercises 5–21, the numbder of decimals places may vary depending on the calculator used.

**5.** .6252427

**6.** 1.1342773

**7.** 1.0273488

**8.** 1.7768146

**9.** 15.055723

**10.** .4771588

**11.** 1.4887142

**12.** −5.7297416

**13.** .6743024

**14.** 1.9074147

**15.** .9999905

**16.** $\cos 14.8° \approx .9668234$

**17.** $\tan 23.4° \approx .4327386$

**18.** $\tan 33° \approx .6494076$

**19.** $\cot 77° \approx .2308682$

**20.** $\sin 3.69° \approx .0643581$

**21.** $\tan 4.72° \approx .0825664$

**22.** $\tan 22° \approx .4040262$

**23.** 55.845496°

**24.** 81.168073°

**25.** 16.166641°

**26.** 30.502748°

**27.** 38.491580°

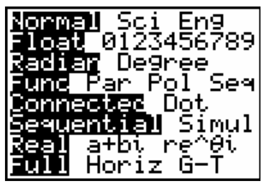
**28.** 46.173582°

**29.** 68.673241°

**30.** 57.997172°

**31.** 45.526434°

**32.** A common mistake is to have the calculator in radian mode, when it should be in degree mode (and vice verse).


**33.** If the calculator allowed an angle $\theta$ where $0° \le \theta < 360°$, then we would need to find an angle within this interval that is coterminal with 2000° by subtracting a multiple of 360°: $2000° - 5 \cdot 360° = 2000° - 1800° = 200°$. If the calculator was more restrictive on evaluating angles (such as $0° \le \theta < 90°$), then reference angles would need to be used.

**34.** 56°

**35.** .3746065934°

**36.** 1

**37.** −1

**38.** 0

**39.** 1

**40.** 1

**41.** 0

**42.** A: 68.94 mph; B: 65.78 mph.

**43.** $r = a\cos\theta$

**44.** false

**45.** false

**46.** true

**47.** true

**48.** false

**49.** false

**50.** false

**51.** false

**52.** false

**53.** true

**54.** true

**55.** true

**56.** −100.5 lb

**57.** 65.96 lb

**58.** 2771 lb

**59.** −2.87°

**60.** The 2200-lb car on a 2° uphill grade has the greater grade resistance.

**61.** 2.87°

**62.**

| | | | |
|---|---|---|---|
| 0° | .0000 | .0000 | .0000 |
| .5° | .0087 | .0087 | .0087 |
| 1° | .0175 | .0175 | .0175 |
| 1.5° | .0262 | .0262 | .0262 |
| 2° | .0349 | .0349 | .0349 |
| 2.5° | .0436 | .0437 | .0436 |
| 3° | .0523 | .0524 | .0524 |
| 3.5° | .0610 | .0612 | .0611 |
| 4° | .0698 | .0699 | .0698 |

**(a)** if $\theta$ is small, $\sin\theta = \tan\theta = \dfrac{\pi\theta}{180}$.

**(b)** $F = W\sin\theta = W\tan\theta = \dfrac{W\pi\theta}{180}$

**(c)** 80 lb

**(d)** 117.81 lb

**63.** **(a)** 703 ft

**(b)** 1701 ft

**(c)** $R$ will *decreas*; 644 ft; 1559 ft

**64.** 55 mph

**65.** **(a)** $2 \times 10^8$ m per sec

**(b)** $2 \times 10^8$ m per sec

**66.** **(a)** 19°

**(b)** 50°

**67.** 48.7°

**68.** 40.8°

**69.** **(a)** $\approx 155$ ft

**(b)** $\approx 194$ ft

**70.** $\approx 78$ mph

# Chapter 2 Quiz

**(Sections 2.1–2.3)**

1. $\sin A = \frac{3}{5}$; $\cos A = \frac{4}{5}$; $\tan A = \frac{3}{4}$

2.

| $\theta$ | $\sin\theta$ | $\cos\theta$ | $\tan\theta$ | $\cot\theta$ | $\sec\theta$ | $\csc\theta$ |
|---|---|---|---|---|---|---|
| 30° | $\frac{1}{2}$ | $\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{3}}{3}$ | $\sqrt{3}$ | $\frac{2\sqrt{3}}{3}$ | 2 |
| 45° | $\frac{\sqrt{2}}{2}$ | $\frac{\sqrt{2}}{2}$ | 1 | 1 | $\sqrt{2}$ | $\sqrt{2}$ |
| 60° | $\frac{\sqrt{3}}{2}$ | $\frac{1}{2}$ | $\sqrt{3}$ | $\frac{\sqrt{3}}{3}$ | 2 | $\frac{2\sqrt{3}}{3}$ |

3. $w = 18;\ x = 18\sqrt{3};\ y = 18;\ z = 18\sqrt{2}$

4. $3x^2 \sin\theta$ .

5. $\frac{\sqrt{2}}{2}$ ; $-\frac{\sqrt{2}}{2}$ ; $-1$ ; $-1$ ; $-\sqrt{2}$ ; $\sqrt{2}$

6. $-\frac{1}{2}; -\frac{\sqrt{3}}{2}; \frac{\sqrt{3}}{3}; \sqrt{3}; -\frac{2\sqrt{3}}{3}; -2$

7. $-\frac{\sqrt{3}}{2}; \frac{1}{2};; -\sqrt{3}; -\frac{\sqrt{3}}{3}; 2; -\frac{2\sqrt{3}}{3}$

8. 60° ; 120° .

9. 135°; 225°

10. .67301251

11. −1.18176327

12. 69.497888°

13. 24.777233°

14. false

15. true

## Section 2.4: Solving Right Triangles

1. 22,894.5 to 22,895.5

2. 28,999.5 to 29,000.5

3. 8958.5 to 8959.5

4. Answers will vary.
   No; the number of points scored will be a whole number.

5. Answers will vary.
   It would be cumbersome to write 2 as 2.00 or 2.000, for example, if the measurements had 3 or 4 significant digits (depending on the problem). In the formula, it is understood that 2 is an exact value. Since the radius measurement, 54.98 cm, has four significant digits, an appropriate answer would be 345.4 cm.

6. 23.0 ft indicates 3 significant digits and 23.00 ft indicates four significant digits.

7. .05

8. .5

9. $B = 53°40'$; $a \approx 571$ m ; $b \approx 777$ m

10. $B = 58°20'$ ; $c \approx 68.4$ km ; $b \approx 58.2$ km

11. $M° = 38.8°$ ; $n \approx 154$ m ; $p \approx 198$ m

12. $Y = 42.2°$ ; $x \approx 66.4$ cm ; $y \approx 60.2$ cm

13. $A = 47.9108°$ ; $c \approx 84.816$ cm ; $a \approx 62.942$ cm

14. $A = 21.4858°$ ; $b \approx 3330.68$ m ; $a \approx 1311.04$ m

15. $A = 37°40'$ ; $B = 52°20'$ ; $c = 20.5$ ft

16. $A = 18°20'$ ; $B = 71°40'$ ; $b \approx 14.5$ m

17. No; You need to have at least one side to solve the triangle.

18. The other acute angle requires the least work to find.

19. Answers will vary. If you know one acute angle, the other acute angle may be found by subtracting the given acute angle from 90°. If you know one of the sides, then choose two of the trigonometric ratios involving sine, cosine or tangent that involve the known side in order to find the two unknown sides.

20. Answers will vary. If you know the lengths of two sides, you can set up a trigonometric ratio to solve for one of the acute angles. The other acute angle may be found by subtracting the calculated acute angle from 90°. With either of the two acute angles that have been determined, you can set up a trigonometric ratio along with one of the known sides to solve for the missing side.

21. $B = 62.0°$ ; $a \approx 8.17$ ft ; $b \approx 15.4$ ft

22. $A = 44.0°$ ; $a \approx 20.6$ m ; $b \approx 21.4$ m

23. $A = 17.0°$; $a = 39.1$ in; $c = 134$ in

**24.** $B = 29.0°$ ; $a \approx 70.7$ cm ; $c \approx 80.9$ cm

**25.** $B = 27.5°$ ; $b \approx 6.61$ m; $c \approx 14.3$ m

**26.** $A = 38.3°$ ; $b \approx 35.6$ ft; $c \approx 45.3$ ft

**27.** $A \approx 36°$ ; $B \approx 54°$ ; $b \approx 18$ m

**28.** $A \approx 51°$ ; $B \approx 39°$ ; $a \approx 40$ ft

**29.** $A \approx 62°50'$ ; $B \approx 27°10'$ ; $c \approx 85.9$ yd

**30.** $A \approx 63°00'$ ; $B \approx 27°00'$ ; $c \approx 1080$ m

**31.** $A \approx 24°10'$ ; $B \approx 65°50'$ ; $b \approx 42.3$ cm

**32.** $A \approx 70°10'$ ; $B \approx 19°50'$ ; $a \approx 609$ m

**33.** $B = 36°36'$ ; $a \approx 310.8$ ft; $b \approx 230.8$ ft

**34.** $B = 76°13'$ ; $a \approx 306.2$ m; $b \approx 1248$ m

**35** $A = 50°51'$ ; $a \approx .4832$ m ; $b \approx .3934$ m

**36.** $A = 7°9'$ ; $a \approx .6006$ m ; $b \approx 4.787$ m

**37.** The angle of elevation from *X* to *Y* (with *Y* above *X*) is the acute angle formed by ray *XY* and a horizontal ray with endpoint at *X*.

**38.** no

**39.** Answers will vary. The angle of elevation and the angle of depression are measured between the line of sight and a horizontal line. So, in the diagram, lines *AD* and *CB* are both horizontal. Hence, they are parallel. The line formed by *AB* is a transversal and angles *DAB* and *ABC* are alternate interior angle and thus have the same measure.

**40.** The angle of depression is measured between the line of sight and a horizontal line. This angle is measured between the line of sight and a vertical line.

**41.** 9.35

**42.** 33.4 m

**43.** 128 ft

**44.** 864,900 mi

**45.** 26.92 in.

**46.** 134.7 cm

**47.** 22°.

**48.** 583 ft.

**49.** 28.0 m

**50.** 469 m

**51.** 13.3 ft

**52.** 42,600 ft

**53.** 146 m.

**54.** 37°35′

**55.** **(a)** 29,000 ft.
**(b)** shorter

**56.** 34.0 mi

## Section 2.5: Further Applications of Right Triangles

**1.** It should be shown as an angle measured clockwise from due north.

**2.** It should be shown measured from north (or south) in the east (or west) direction.

**3.** A sketch is important to show the relationships among the given data and the unknowns.

**4.** The angle of elevation (or depression) from *X* to *Y* is measured from the horizontal line through *X* to the ray *XY*.

**5.** 270°; N 90° W, or S 90° W.

**6.** 225°; S 45° W

**7.** 315°; N 45° W

**8.** 180°; S 0° E or S 0º W

**9.** 0°; N 0° E or N 0º W

**10.** 45°; N 45° E

**11.** 135°; S 45° E

**12.** 90°; N 90° E, or S 90° E.

**13.** $y = \frac{\sqrt{3}}{3}x, x \le 0$

**14.** $y = -\sqrt{3}x, x \ge 0$

**15.** 220 mi

**16.** 150 km

**17.** 47 nautical mi

**18.** 5856 m

**19.** 140 mi

**20.** 130 mi

**21.** 148 mi

**22.** 2.01 mi

**23.** $x = \dfrac{b}{a-c}$

**24.** $\tan\theta = -\tan(180° - \theta) = -\tan\theta'$. This is because the angle represented by $180° - \theta$ terminates in quadrant II if $0° < \theta < 90°$. If $90° < \theta < 180°$, then the angle represented by $180° - \theta$ terminates in quadrant I. Thus, $\tan\theta$ and $\tan(180° - \theta)$ are opposite in sign.

The slope of the line is $m = -\frac{b}{a}$, and $\tan\theta = -\tan(180° - \theta) = -\tan\theta' = -\frac{b}{a}$. Thus, $m = -\frac{b}{a} = \tan\theta$. The point-slope form of the equation of a line is $y - y_1 = m(x - x_1)$. Substituting $\tan\theta$ for $m$ into $y - y_1 = m(x - x_1)$, we have $y - y_1 = -\tan\theta(x - x_1)$.

The line passes through ($a$, 0), so $y - y_1 = \tan\theta(x - x_1) \Rightarrow$ $y - 0 = \tan\theta(x - a) \Rightarrow y = \tan\theta(x - a)$.

**25.** $y = \tan 35°(x - 25)$

**26.** $y = \tan 15°(x - 5)$

**27.** 433 ft

**28.** 448 m

**29.** 114 ft

**30.** 147 m

**31.** 5.18 m

**32.** 2.47 km

**33.** **(a)** $d = \frac{b}{2}\left(\cot\frac{\alpha}{2} + \cot\frac{\beta}{2}\right)$

**(b)** 345.4 cm.

**34.** 1.95 mi

**35.** 10.8 ft

**36.** $A \approx 35.987°$ or $35°59'10''$
$B \approx 54.013°$ or $54°00'50''$

**37.** **(a)** 320 ft

**(b)** $R\left(1 - \cos\frac{\theta}{2}\right)$

**38.** 84.7 m

**39.** **(a)** 23 ft

**(b)** 48 ft

**(c)** The faster the speed, the more land needs to be cleared on the inside of the curve.

## Chapter 2: Review Exercises

**1.** $\frac{60}{61}; \frac{11}{61}; \frac{60}{11}; \frac{11}{60}; \frac{61}{11}; \frac{61}{60}$

**2.** $\frac{20}{29}; \frac{21}{29}; \frac{20}{21}; \frac{21}{20}; \frac{29}{21}; \frac{29}{20}$

**3.** 10°

**4.** 10°

**5.** 7°

**6.** 30°

**7.** true

**8.** false; For $0° \le \theta \le 90°$; $\cos\theta$ decreases.

**9.** true.

**10.** false; For all $\theta \neq \frac{\pi}{2} + n\pi, -1 < \sin\theta < 1$ and $\csc\theta$ or $\csc\theta$ 1.

**11.** The sum of the measures of angles $A$ and $B$ is 90°, and, thus, they are complementary angles. Since sine and cosine are cofunctions, we have $\sin B = \cos(90° - B) = \cos A$.

**12.** $\frac{\sqrt{3}}{2}; -\frac{1}{2}; -\sqrt{3}; -\frac{\sqrt{3}}{3}; -2; \frac{2\sqrt{3}}{3}$

**13.** $-\frac{\sqrt{3}}{2}; \frac{1}{2}; -\sqrt{3}; -\frac{\sqrt{3}}{3}; 2; -\frac{2\sqrt{3}}{3}$

**14.** $\frac{\sqrt{2}}{2}; -\frac{\sqrt{2}}{2}; -1; -1; -\sqrt{2}; \sqrt{2}$

**15.** $-\frac{1}{2}; \frac{\sqrt{3}}{2}; -\frac{\sqrt{3}}{3}; -\sqrt{3}; \frac{2\sqrt{3}}{3}; -2$

**16.** 210°; 330°.

**17.** 120°; 240°

**18.** 135°; 315°

**19.** 150°; 210°

**20.** 1

**21.** $3 - \frac{2\sqrt{3}}{3}$

**22.** $\frac{7}{2}$

**23.** **(a)** $-\frac{\sqrt{2}}{2}$; $-\frac{\sqrt{2}}{2}$; 1

**(b)** $-\frac{\sqrt{3}}{2}$; $\frac{1}{2}$; $-\sqrt{3}$

**24.** .95371695

**25.** −1.3563417

**26.** −.71592968

**27.** 1.0210339

**28.** 1.9362132

**29.** .20834446

**30.** D

**31.** $\theta \approx 55.673870°$ **32.** $\theta \approx 41.635092°$

**33.** $\theta \approx 12.733938°$ **34.** $\theta \approx 37.695528°$

**35.** $\theta \approx 63.008286°$ **36.** $\theta \approx 5.9998273°$

**37.** 47.1°; 132.9° **38.** 54.2º; 234.2º

**39.** false; 1.408832053

**40.** true.

**41.** true.

**42.** $1.338261213 \neq .9945218954$; false.

**43.** No, $\cot 25° = \frac{1}{\tan 25°} \neq \tan^{-1} 25°$.

**44.** II.

**45.** III.

**46.** I.

**47.** $B = 31°30'$; $a = 638$; $b = 391$

**48.** $A = 19°25'$; $B = 70°35'$

**49.** $B = 50.28°$; $a = 32.38$ m; $c = 50.66$ m

**50.** $A = 42°7'$; $a = 270.0$ m; $c = 402.5$ m

**51.** 137 ft

**52.** $r = 13$; $\theta = 23°$

**53.** 73.7 ft

**54.** 20.4 m

**55.** 18.75 cm

**56.** 50.24 m

**57.** 1200 m

**58.** 110 km

**59.** 140 mi

**60.** $h = k(\tan B - \tan A)$

**61.–62.** Answers will vary.

**63.** **(a)** 716 mi.

**(b)** 1104 mi.

**64.** **(a)** $x_Q = x_P + d\sin\theta$; $y_Q = y_P + d\cos\theta$.

**(b)** (181.34, 523.02)

## Chapter 2: Chapter Test

**1.** $\sin A = \frac{12}{13}$; $\cos A = \frac{5}{13}$; $\tan A = \frac{12}{5}$

$\cot A = \frac{5}{12}$; $\sec A = \frac{13}{5}$; $\csc A = \frac{13}{12}$

**2.** $x = 4$; $y = 4\sqrt{3}$; $z = 4\sqrt{2}$; $w = 8$

**3.** 15°

**4.** **(a)** true.

**(b)** false; For $0 \leq \theta \leq 90$, cosine is decreasing.

**(c)** true.

**5.** $-\frac{\sqrt{3}}{2}$; $-\frac{1}{2}$; $\sqrt{3}$; $\frac{\sqrt{3}}{3}$; $-2$; $-\frac{2\sqrt{3}}{3}$

**6.** $-\frac{\sqrt{2}}{2}$; $-\frac{\sqrt{2}}{2}$; 1; 1; $-\sqrt{2}$; $-\sqrt{2}$

**7.** −1; 0; undefined; 0; undefined; −1

**8.** 135°; 225°

**9.** 240°; 300°

**10.** 45°; 225°

**11.** Take the reciprocal of $\tan\theta$ to get $\cot\theta$=.5960011896.

**12.** **(a)** .97939940

**(b)** −1.9056082

**(c)** 1.9362132

**13.** $\theta \approx 16.16664145°$

**14.** $B = 31°30'$; $b = 458$; $c = 877$

**15.** 67.1° or 67°10′

**16.** 15.5 ft

**17.** 8800 ft

**18.** 72 nautical mi

**19.** 92 km

**20.** 448 m.

## Chapter 2: Quantitative Reasoning

**1.** 67.00 ft. ; 67.14 ft ; 66.84 ft ;*D* increases and then decreases.

**2.** 64.40 ft ; 67.14 ft ; 69.93 ft ; *D* increases.

**3.** The velocity affects the distance more. The shot-putter should concentrate on achieving as large a value of *v* as possible.