1.1 Angles, Degrees, and Triangles

Find (a) the complement and (b) the supplement of the given angles.

1. $28°$ 2. $17°$ 3. $35°$ 4. $78°$
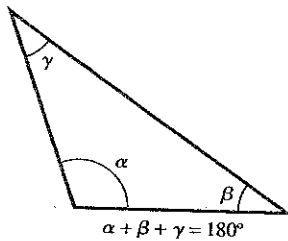
Refer to the following triangle.

5. If $\alpha = 120°$ and $\beta = 35°$, find γ.

6. If $\alpha = 105°$ and $\beta = 25°$, find γ.

7. If $\gamma = \beta$ and $\alpha = 7\beta$, find all three angles.

8. If $\gamma = \beta$ and $\alpha = 6\beta$, find all three angles.

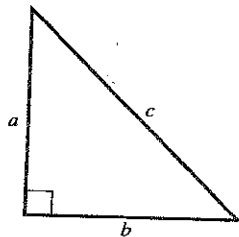$\alpha + \beta + \gamma = 180°$

Refer to the following right triangle.

9. If $a = 4$ and $c = 12$, find b.

10. If $b = 9$ and $c = 15$, find a.
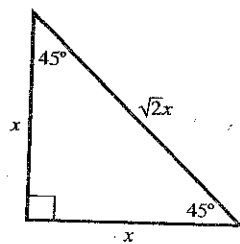
11. If $a = 7$ and $b = 4$, find c.

12. If $a = 10$ and $b = 8$, find c.

Refer to the following 45°-45°-90° triangle.

13. If the two legs have length 12 yards, how long is the hypotenuse?
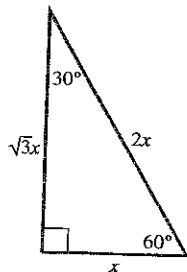
14. If the hypotenuse has length $\sqrt{8}$ feet, how long are the legs?

Refer to the following 30°-60°-90° triangle.

15. If the shorter leg has length 3 feet, what are the lengths of the other leg and the hypotenuse?

16. If the hypotenuse has length 12 kilometers, what are the lengths of the two legs?

Applications

17. **Clock.** What is the measure (in degrees) of the angle that the minute hand sweeps in exactly 25 minutes?

18. **Clock.** What is the measure (in degrees) of the angle that the second hand sweeps in exactly 15 seconds?

1.2 Similar Triangles

Find the measure of the indicated angle.
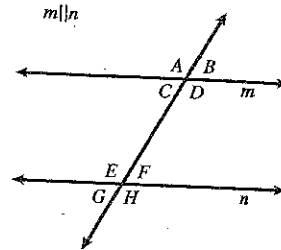
19. $\angle F = 75°$, find $\angle G$.

20. $\angle F = 75°$, find $\angle D$.

21. $\angle F = 75°$, find $\angle C$.

22. $\angle F = 75°$, find $\angle E$.

23. $\angle F = 75°$, find $\angle B$.

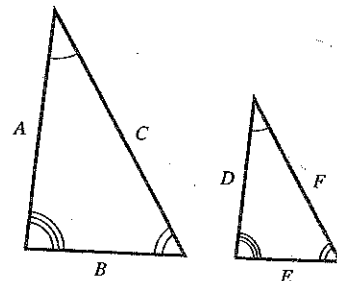24. $\angle F = 75°$, find $\angle A$.

$m \| n$

Calculate the specified lengths given that the two triangles are similar.

25. $A = 10$, $C = 8$, $D = 5$, $F = ?$

26. $A = 15$, $B = 12$, $E = 4$, $D = ?$

27. $D = 4.5$ m, $F = 8.2$ m, $A = 81$ km, $C = ?$

28. $E = 8$ cm, $F = 14$ cm, $C = 8$ m, $B = ?$

Applications

29. **Height of a Tree.** The shadow of a tree measures 9.6 meters. At the same time of day, the shadow of a 4-meter basketball backboard measures 1.2 meters. How tall is the tree?

30. **Height of a Man.** If an NBA center casts a 1 foot 9 inch shadow, and his 4-foot son casts a 1-foot shadow, how tall is the NBA center?

For Exercises 31 and 32, refer to the following:

In a home remodeling project, your architect gives you plans that have an indicated distance of 3 feet, measuring 1 inch with a ruler.
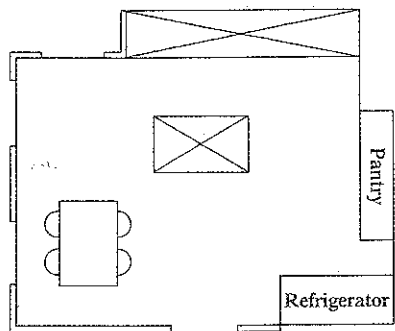

31. Home Renovation. How wide is the built-in refrigerator if it measures $1\frac{1}{3}$ inches with a ruler?

32. Home Renovation. How wide is the pantry if it measures $1\frac{1}{4}$ inches with a ruler?

1.3 Definition 1 of Trigonometric Functions: Right Triangle Ratios

Use the following triangle to find the indicated trigonometric function values. Rationalize any denominators that you encounter in your answers, but leave answers exact.

33. $\cos\theta$

34. $\sin\theta$

35. $\sec\theta$

36. $\csc\theta$

37. $\tan\theta$

38. $\cot\theta$
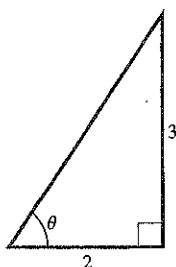
Use the cofunction identities to fill in the blanks.

39. $\sin 30° = \cos$ _____

40. $\cos A = \sin$ _____

41. $\tan 45° = \cot$ _____

42. $\csc 60° = \sec$ _____

Write the trigonometric function in terms of its cofunction.

43. $\sin(30° - x)$

44. $\cos(55° + A)$

45. $\csc(45° - x)$

46. $\sec(60° - \theta)$

1.4 Evaluating Trigonometric Functions: Exactly and with Calculators

Label each trigonometric function value with the corresponding value (a–c).

a. $\dfrac{\sqrt{3}}{2}$ b. $\dfrac{1}{2}$ c. $\dfrac{\sqrt{2}}{2}$

47. $\sin 30°$ **48.** $\cos 30°$ **49.** $\cos 60°$

50. $\sin 60°$ **51.** $\sin 45°$ **52.** $\cos 45°$

Use the results in Exercises 47–52 and the trigonometric quotient identity, $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$, to calculate the following values.

53. $\tan 30°$ **54.** $\tan 45°$ **55.** $\tan 60°$

Use the results in Exercises 47–55 and the reciprocal identities to calculate the following values.

56. $\csc 30°$ **57.** $\csc 45°$ **58.** $\csc 60°$

59. $\sec 30°$ **60.** $\sec 45°$ **61.** $\sec 60°$

62. $\cot 30°$ **63.** $\cot 45°$ **64.** $\cot 60°$

Use a calculator to approximate the following trigonometric function values. Round answers to four decimal places.

65. $\sin 42°$ **66.** $\cos 57°$ **67.** $\cos 17.3°$

68. $\tan 25.2°$ **69.** $\cot 33°$ **70.** $\sec 16.8°$

71. $\csc 40.25°$ **72.** $\cot 19.76°$

Convert from degrees-minutes-seconds to decimal degrees. Round to the nearest hundredth if only minutes are given and to the nearest thousandth if seconds are given.

73. $39° 17'$ **74.** $68° 15'$

75. $29° 30' 25''$ **76.** $25° 45' 15''$

Convert from decimal degrees to degrees-minutes-seconds.

77. $42.25°$ round to the nearest minute

78. $60.45°$ round to the nearest minute

79. $30.175°$ round to the nearest second

80. $25.258°$ round to the nearest second

Applications

Light bends according to Snell's law, which states:
$$n_i \sin(\theta_i) = n_r \sin(\theta_r)$$

- n_i is the refractive index of the medium the light is leaving.

- θ_i is the incident angle between the light ray and the normal (perpendicular) to the interface between mediums.

- n_r is the refractive index of the medium the light is entering.

- θ_r is the refractive angle between the light ray and the normal (perpendicular) to the interface between mediums.
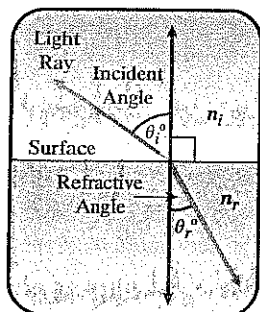
Calculate the index of refraction n_r of the indicated refractive medium given the following assumptions:

- The incident medium is air.
  - Air has an index of refraction value of $n_i = 1.00$.
  - The incidence angle is $\theta_i = 60°$.

81. Optics. Glass, $\theta_r = 35.26°$

82. Optics. Glycerin, $\theta_r = 36.09°$

1.5 Solving Right Triangles

Use the right triangle diagram below and the information given to find the indicated measure. Write your answers for angle measures in decimal degrees.

83. $\beta = 25°$, $c = 15$ in., find a.

84. $\alpha = 50°$, $c = 27$ ft, find a.

85. $\alpha = 33.5°$, $b = 21.9$ mi, find a.

86. $\alpha = 47.45°$, $a = 19.22$ cm, find c.

87. $\beta = 37°45'$, $a = 120.0$ yd, find b.

**88.** $\beta = 75°10'$, $b = 96.5$ km, find c.
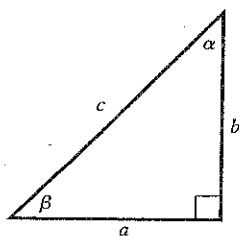
Use the right triangle diagram below and the information given to solve the right triangle. Write your answers for angle measures in decimal degrees.

89. $\alpha = 30°$ and $c = 21$ ft

90. $\beta = 65°$ and $c = 8.5$ mm

91. $\alpha = 48.5°$ and $a = 215$ mi

92. $\alpha = 30°15'$ and $b = 2154$ ft

93. $a = 30.5$ ft and $b = 45.7$ ft

94. $a = 11,798$ km and $c = 32,525$ km
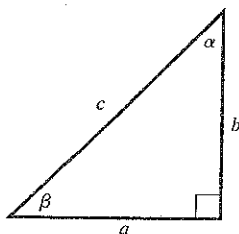
Applications

The illustration below shows a mid-air refueling scenario which our military aircraft often use. Assume the elevation angle that the hose makes with the plane being fueled is $\theta = 30°$.
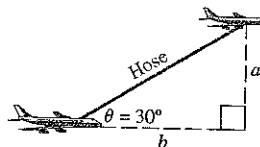
95. Midair Refueling. If the hose is 150 feet long, what should the altitude difference, a, be between the two planes?

96. Midair Refueling. If the smallest acceptable altitude difference, a, between the two planes is 100 feet, how long should the hose be?

Technology Exercises

Section 1.1

Assume a 30°-60°-90° triangle. Round your answers to two decimal places.

97. If the shorter leg has length 41.32 feet, what are the lengths of the other leg and hypotenuse?

98. If the longer leg has length 87.65 cm, what are the lengths of the other leg and the hypotenuse?

Section 1.2

99. Calculate $\csc 78.4°$ in the following two ways:
  a. Find $\sin 78.4°$ to three decimal places and then divide 1 by that number. Write that number to five decimal places.
  b. In a calculator: 78.4, sin, 1/x, round to five decimal places.

100. Calculate $\cot 34.8°$ in the following two ways:
  a. Find $\tan 34.8°$ to three decimal places and then divide 1 by that number. Write that number to five decimal places.
  b. In a calculator: 34.8, tan, 1/x, round to five decimal places.

Section 1.3

101. Use a calculator to find $\tan(\tan^{-1} 2.612)$.

102. Use a calculator to find $\cos(\cos^{-1} 0.125)$.

Section 1.4

Use a calculator to evaluate the following expressions. If you get an error, explain why.

103. $\sec 180°$

104. $\csc 180°$

1. Calculate the measure of three angles in a triangle if the following are true:

   • The measure of the largest angle is 5 times the measure of the smallest angle.

   and

   • The larger of the two acute angles is 3 times the measure of the smallest angle.

2. In a right triangle, if the side opposite a 30° angle has a length of 5 cm, what is the length of the other leg and the hypotenuse?

3. A 5-foot girl is standing *in* the Grand Canyon, and she wants to estimate the height (depth) of the canyon. The sun casts her shadow 6 inches along the ground. To measure the shadow cast by the top of the canyon, she walks the length of the shadow. She takes 200 steps and estimates that each step is roughly 3 feet. Approximately how deep is the Grand Canyon?
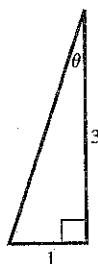
For Exercises 4 and 5, use the triangle below:

4. Find the exact values for the indicated functions.

   a. $\sin\theta$ **b.** $\cos\theta$ **c.** $\tan\theta$

   d. $\sec\theta$ **e.** $\csc\theta$ **f.** $\cot\theta$

5. Find the exact values for the indicated functions.

   a. $\sin(90° - \theta)$ **b.** $\sec(90° - \theta)$

   c. $\cot(90° - \theta)$
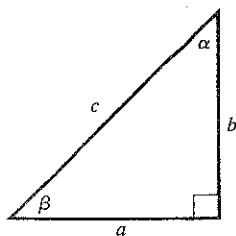
6. Fill in the exact values in the table below.

θ	SIN θ	COS θ	TAN θ	COT θ	SEC θ	CSC θ
30°						
45°						
60°						

7. Use a calculator to approximate $\sec 42.8°$. Round your answer to four decimal places.

8. What is the difference between $\cos\theta = \frac{2}{3}$ and $\cos\theta \approx 0.6\overline{6}$?

9. Convert $33°45'20''$ to decimal degrees. Round to the appropriate decimal place.

For Exercises 10–15, refer to the triangle below:

10. If $\alpha = 20°$ and $a = 10$ cm, find b.

11. If $a = 9.2$ km and $c = 23$ km, find β.

12. If $\beta = 50°$ and $a = 12$ mm, find c.

13. If $b = 13.3$ ft and $c = 14.0$ ft, find β.

14. If $\alpha = 33°10'$ and $c = 47$ m, find a.

15. If $a = 3.45$ and $b = 6.78$, find α.

16. What is the measure (in degrees) of the angle that a second hand sweeps in 5 seconds?

17. Light going from air to quartz crystal appears to bend according to Snell's Law: $n_i \sin(\theta_i) = n_r \sin(\theta_r)$. Air has an index of refraction value of $n_i = 1.00$. If the incidence angle is 25°, $\theta_i = 25°$, and the refraction angle in the quartz is $\theta_r = 16°$, what is the index of refraction of quartz crystal?

18. If the search and rescue helicopter has a field of view of 40° and is flying at an altitude of 150 feet above sea level, what is the diameter of the circle that is illuminated on the surface of the water?
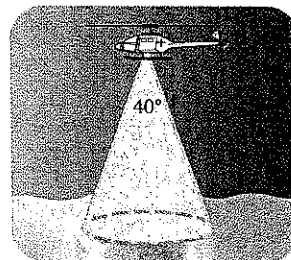
19. Convert 44.27° from decimal degrees to degrees-minutes-seconds.

20. Convert $22°10'23''$ from degrees-minutes-seconds to decimal degrees. Round to the nearest hundredth of a degree.

21. If $\sin 75° = \dfrac{\sqrt{6} + \sqrt{2}}{4}$, find the exact value of $\csc 75°$ and $\cos 15°$.

22. Find the exact value of $\sin 60° + \dfrac{\cos 45°}{\cot 30°}$.

23. Perform the indicated operation: $12°40' + 55°49'$.

24. Perform the indicated operation: $82°27' - 35°39'$.

25. The angle of elevation to the top of a building is 72° from a point 200 yards from the base of the building. How tall is the building?