

GETTING READY FOR CLASS

After reading through the preceding section, respond in your own words and in complete sentences.

- What is a radian?
- What is radian measure?
- Explain how to convert from radian measure to degree measure.
- Explain how to convert from degree measure to radian measure.

PROBLEM SET 3.2

Find the radian measure of angle θ , if θ is a central angle in a circle of radius r , and θ cuts off an arc of length s .

- $r = 3$ cm, $s = 9$ cm
- $r = 6$ cm, $s = 3$ cm
- $r = 10$ inches, $s = 5$ inches
- $r = 5$ inches, $s = 10$ inches
- $r = 4$ inches, $s = 12\pi$ inches
- $r = 3$ inches, $s = 12$ inches
- $r = \frac{1}{4}$ cm, $s = \frac{1}{2}$ cm
- $r = \frac{1}{4}$ cm, $s = \frac{1}{8}$ cm

9. Angle Between Cities Los Angeles and San Francisco are approximately 450 miles apart on the surface of the earth. Assuming that the radius of the earth is 4,000 miles, find the radian measure of the central angle with its vertex at the center of the earth that has Los Angeles on one side and San Francisco on the other side (Figure 12).

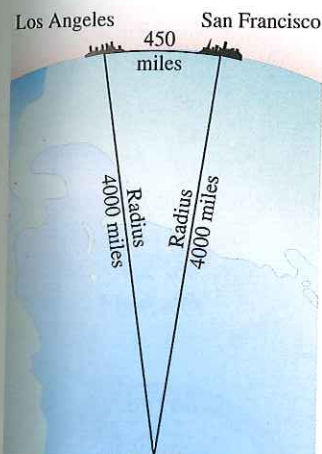


Figure 12

10. Angle Between Cities Los Angeles and New York City are approximately 2,500 miles apart on the surface of the earth. Assuming that the radius of the earth is 4,000 miles, find the radian measure of the central angle with its vertex at the center of the earth that has Los Angeles on one side and New York City on the other side.

For each angle below:

- Draw the angle in standard position.
- Convert to radian measure using exact values.
- Name the reference angle in both degrees and radians.

- | | | | |
|-----------------|-----------------|------------------|------------------|
| 11. 30° | 12. 60° | 13. 90° | 14. 270° |
| 15. 260° | 16. 340° | 17. -150° | 18. -210° |
| 19. 420° | 20. 390° | 21. -135° | 22. -120° |

For Problems 23–26, use 3.1416 for π unless your calculator has a key marked π .

- Use a calculator to convert $120^\circ 40'$ to radians. Round your answer to the nearest hundredth. (First convert to decimal degrees, then multiply by the appropriate conversion factor to convert to radians.)
- Use a calculator to convert $256^\circ 20'$ to radians to the nearest hundredth of a radian.
- Use a calculator to convert $1'$ (1 min) to radians to three significant digits.
- Use a calculator to convert 1° to radians to three significant digits.

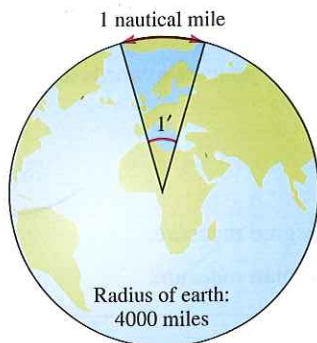


Figure 13

27. Nautical Miles If a central angle with its vertex at the center of the earth has a measure of $1'$, then the arc on the surface of the earth that is cut off by this angle has a measure of 1 nautical mile (Figure 13). Find the number of regular (statute) miles in 1 nautical mile to the nearest hundredth of a mile. (Use 4000 miles for the radius of the earth.)

28. Nautical Miles If two ships are 20 nautical miles apart on the ocean, how many statute miles apart are they? (Use the result of Problem 27 to do the calculations.)

29. Clock Through how many radians does the minute hand of a clock turn during a 5-minute period?

30. Clock Through how many radians does the minute hand of a clock turn during a 25-minute period?

For each angle below:

a. Convert to degree measure.

b. Draw the angle in standard position.

c. Label the reference angle in both degrees and radians.

31. $\frac{\pi}{3}$

32. $\frac{\pi}{4}$

33. $\frac{2\pi}{3}$

34. $\frac{3\pi}{4}$

35. $-\frac{7\pi}{6}$

36. $-\frac{5\pi}{6}$

37. $\frac{5\pi}{3}$

38. $\frac{7\pi}{3}$

39. 4π

40. 3π

41. $\frac{\pi}{12}$

42. $\frac{5\pi}{12}$

Use a calculator to convert each of the following to degree measure to the nearest tenth of a degree.

43. 1

44. 2

45. 1.3

46. 2.4

47. 0.75

48. 0.25

49. 5

50. 6

Give the exact value of each of the following:

51. $\sin \frac{4\pi}{3}$

52. $\cos \frac{4\pi}{3}$

53. $\tan \frac{\pi}{6}$

54. $\cot \frac{\pi}{3}$

55. $\sec \frac{2\pi}{3}$

56. $\csc \frac{3\pi}{2}$

57. $\csc \frac{5\pi}{6}$

58. $\sec \frac{5\pi}{6}$

59. $4 \sin \left(-\frac{\pi}{4}\right)$

60. $4 \cos \left(-\frac{\pi}{4}\right)$

61. $-\sin \frac{\pi}{4}$

62. $-\cos \frac{\pi}{4}$

63. $2 \cos \frac{\pi}{6}$

64. $2 \sin \frac{\pi}{6}$

Evaluate each of the following expressions when x is $\frac{\pi}{6}$. In each case, use exact values.

65. $\sin 2x$

66. $\sin 3x$

67. $6 \cos 3x$

68. $6 \cos 2x$

69. $\sin \left(x + \frac{\pi}{2}\right)$

70. $\sin \left(x - \frac{\pi}{2}\right)$

71. $4 \cos \left(2x + \frac{\pi}{3}\right)$

72. $4 \cos \left(3x + \frac{\pi}{6}\right)$

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is cut off by this an-
e number of regular
of a mile. (Use 4,000

the ocean, how many
?7 to do the calcula-

f a clock turn during

f a clock turn during

34. $\frac{3\pi}{4}$

38. $\frac{7\pi}{3}$

42. $\frac{5\pi}{12}$

measure to the nearest

46. 2.4

50. 6

54. $\cot \frac{\pi}{3}$

58. $\sec \frac{5\pi}{6}$

64. $2 \sin \frac{\pi}{6}$

each case, use exact

68. $6 \cos 2x$



Figure 14



Figure 15

For the following expressions, find the value of y that corresponds to each value of x , then write your results as ordered pairs (x, y) .

73. $y = \sin x$ for $x = 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi$

74. $y = \cos x$ for $x = 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi$

75. $y = 2 \sin x$ for $x = 0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$

76. $y = \frac{1}{2} \cos x$ for $x = 0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$

77. $y = \sin 2x$ for $x = 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi$

78. $y = \cos 3x$ for $x = 0, \frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}, \frac{2\pi}{3}$

79. $y = \sin\left(x - \frac{\pi}{2}\right)$ for $x = \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi, \frac{5\pi}{2}$

80. $y = \cos\left(x - \frac{\pi}{6}\right)$ for $x = \frac{\pi}{6}, \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{7\pi}{6}$

81. $y = 3 \sin\left(2x + \frac{\pi}{2}\right)$ for $x = -\frac{\pi}{4}, 0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}$

82. $y = 5 \cos\left(2x - \frac{\pi}{3}\right)$ for $x = \frac{\pi}{6}, \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{7\pi}{6}$

83. **Cycling** The Shimano WH-R540 aluminum wheel has 8 pairs of spokes evenly distributed around the rim of the wheel. What is the measure, in radians, of the central angle formed by adjacent pairs of spokes (Figure 14)?

84. **Cycling** The Mavic Ksyrium Elite wheel has 18 spokes evenly distributed around the rim of the wheel. What is the measure, in radians, of the central angle formed by adjacent spokes (Figure 15)?

REVIEW PROBLEMS

The problems that follow review material we covered in Section 1.3.

Find all six trigonometric functions of θ , if the given point is on the terminal side of θ .

85. $(1, -3)$

86. $(-1, 3)$

87. (m, n)

88. (a, b)

89. Find the remaining trigonometric functions of θ , if $\sin \theta = \frac{1}{2}$ and θ terminates in QII.

90. Find the remaining trigonometric functions of θ , if $\cos \theta = -1/\sqrt{2}$ and θ terminates in QII.

91. Find all six trigonometric functions of θ , if the terminal side of θ lies along the line $y = 2x$ in QI.

92. Find the six trigonometric functions of θ , if the terminal side of θ lies along the line $y = 2x$ in QIII.