# 4.1 Exercises

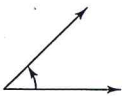
See CalcChat.com for tutorial help and worked-out solutions to odd-numbered exercises.

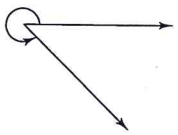
**Vocabulary: Fill in the blanks.**

1. Two angles that have the same initial and terminal sides are _____.
2. One _____ is the measure of a central angle that intercepts an arc equal in length to the radius of the circle.
3. Two positive angles that have a sum of $\pi/2$ are _____ angles, and two positive angles that have a sum of $\pi$ are _____ angles.
4. The angle measure that is equivalent to a rotation of $\frac{1}{360}$ of a complete revolution about an angle's vertex is one _____.
5. The _____ speed of a particle is the ratio of the arc length traveled to the elapsed time, and the _____ speed of a particle is the ratio of the change in the central angle to the elapsed time.
6. The area $A$ of a sector of a circle with radius $r$ and central angle $\theta$, where $\theta$ is measured in radians, is given by the formula _____.

## Skills and Applications

**Estimating an Angle** **In Exercises 7–10, estimate the angle to the nearest one-half radian.**

7. 

8. 

9. 

10. 

**Determining Quadrants** **In Exercises 11 and 12, determine the quadrant in which each angle lies.**

11. (a) $\frac{\pi}{4}$ (b) $-\frac{5\pi}{4}$

12. (a) $-\frac{\pi}{6}$ (b) $\frac{11\pi}{9}$

**Sketching Angles** **In Exercises 13 and 14, sketch each angle in standard position.**

13. (a) $\frac{\pi}{3}$ (b) $-\frac{2\pi}{3}$

14. (a) $\frac{5\pi}{2}$ (b) 4

**Finding Coterminal Angles** **In Exercises 15 and 16, determine two coterminal angles (one positive and one negative) for each angle. Give your answers in radians.**

15. (a) $\frac{\pi}{6}$ (b) $-\frac{5\pi}{6}$

16. (a) $\frac{2\pi}{3}$ (b) $-\frac{9\pi}{4}$

**Complementary and Supplementary Angles** **In Exercises 17–20, find (if possible) the complement and supplement of each angle.**

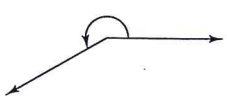
17. (a) $\frac{\pi}{12}$ (b) $\frac{11\pi}{12}$

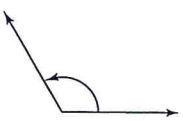
18. (a) $\frac{\pi}{3}$ (b) $\frac{\pi}{4}$

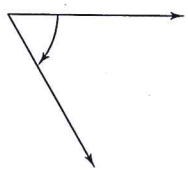
19. (a) 1 (b) 2

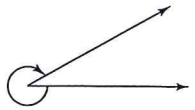
20. (a) 3 (b) 1.5

**Estimating an Angle** **In Exercises 21–24, estimate the number of degrees in the angle.**

21. 

22. 

23. 

24. 

**Determining Quadrants** **In Exercises 25 and 26, determine the quadrant in which each angle lies.**

25. (a) 130° (b) −8.3°

26. (a) −132° 50′ (b) 3.4°

**Sketching Angles** **In Exercises 27 and 28, sketch each angle in standard position.**

27. (a) 270° (b) −120°

28. (a) 135° (b) −750°

**Finding Coterminal Angles** **In Exercises 29 and 30, determine two coterminal angles (one positive and one negative) for each angle. Give your answers in degrees.**

29. (a) 120° (b) −210°

30. (a) 45° (b) −420°

**Complementary and Supplementary Angles** **In Exercises 31–34, find (if possible) the complement and supplement of each angle.**

31. (a) 18° (b) 85°

32. (a) 46° (b) 93°

33. (a) 24° (b) 126°

34. (a) 130° (b) 170°

**Converting from Degrees to Radians** In Exercises 35 and 36, convert each degree measure to radian measure as a multiple of $\pi$. Do not use a calculator.

35. (a) $120°$ (b) $-20°$

36. (a) $-60°$ (b) $144°$

**Converting from Radians to Degrees** In Exercises 37 and 38, convert each radian measure to degree measure. Do not use a calculator.

37. (a) $\frac{3\pi}{2}$ (b) $-\frac{7\pi}{6}$

38. (a) $-\frac{7\pi}{12}$ (b) $\frac{5\pi}{4}$

**Converting from Degrees to Radians** In Exercises 39–42, convert the degree measure to radian measure. Round to three decimal places.

39. $45°$

40. $-48.27°$

41. $-0.54°$

42. $345°$

**Converting from Radians to Degrees** In Exercises 43–46, convert the radian measure to degree measure. Round to three decimal places, if necessary.

43. $\frac{5\pi}{11}$

44. $\frac{15\pi}{8}$

45. $-4.2\pi$

46. $-0.57$

**Converting to Decimal Degree Form** In Exercises 47 and 48, convert each angle measure to decimal degree form.

47. (a) $54° 45'$ (b) $-128° 30'$

48. (a) $135° 10' 36''$ (b) $-408° 16' 20''$

**Converting to D° M′ S″ Form** In Exercises 49 and 50, convert each angle measure to D° M′ S″ form.

49. (a) $240.6°$ (b) $-145.8°$

50. (a) $345.12°$ (b) $-3.58°$

**Finding Arc Length** In Exercises 51 and 52, find the length of the arc on a circle of radius $r$ intercepted by a central angle $\theta$.

51. $r = 15$ inches, $\theta = 120°$

52. $r = 3$ meters, $\theta = 150°$

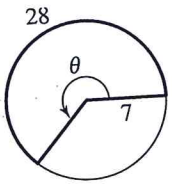
**Finding the Central Angle** In Exercises 53 and 54, find the radian measure of the central angle of a circle of radius $r$ that intercepts an arc of length $s$.

53. $r = 80$ kilometers, $s = 150$ kilometers

54. $r = 14$ feet, $s = 8$ feet

**Finding the Central Angle** In Exercises 55 and 56, find the radian measure of the central angle.

55.

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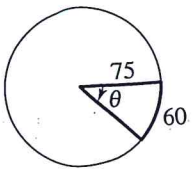



**Area of a Sector of a Circle** In Exercises 57 and 58, find the area of the sector of a circle of radius $r$ and central angle $\theta$.

57. $r = 6$ inches, $\theta = \frac{\pi}{3}$

58. $r = 2.5$ feet, $\theta = 225°$

**Error Analysis** In Exercises 59 and 60, describe the error.

59. $20° = (20 \cancel{\text{deg}})\left(\frac{180 \text{ rad}}{\pi \cancel{\text{deg}}}\right) = \frac{3600}{\pi}$ rad

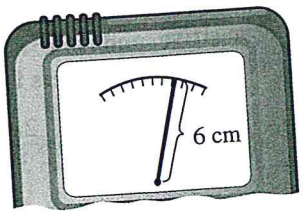
60. A circle has a radius of 6 millimeters. The length of the arc intercepted by a central angle of $72°$ is

$s = r\theta$
$= 6(72)$
$= 432$ millimeters.

**Earth-Space Science** In Exercises 61 and 62, find the distance between the cities. Assume that Earth is a sphere of radius 4000 miles and that the cities are on the same longitude (one city is due north of the other).

| | City | Latitude |
|---|---|---|
| 61. | Dallas, Texas | $32° 47' 9''$ N |
| | Omaha, Nebraska | $41° 15' 50''$ N |
| 62. | San Francisco, California | $37° 47' 36''$ N |
| | Seattle, Washington | $47° 37' 18''$ N |

63. **Instrumentation** The pointer on a voltmeter is 6 centimeters in length (see figure). Find the number of degrees through which the pointer rotates when it moves 2.5 centimeters on the scale.




64. **Linear and Angular Speed** A $7\frac{1}{4}$-inch circular power saw blade rotates at 5200 revolutions per minute.

(a) Find the angular speed of the saw blade in radians per minute.

(b) Find the linear speed (in feet per minute) of the saw teeth as they contact the wood being cut.