

QUICK REVIEW 4.1*(For help, go to Section 1.6.)*

In Exercises 1 and 2, find the circumference of the circle with the given radius r . State the correct unit.

1. $r = 2.5$ in.

2. $r = 4.6$ m

In Exercises 3 and 4, find the radius of the circle with the given circumference C .

3. $C = 12$ m

4. $C = 8$ ft

In Exercises 5 and 6, evaluate the expression for the given values of the variables. State the correct unit.

5. $s = r\theta$

-(a) $r = 9.9$ ft

$\theta = 4.8$ rad

(b) $r = 4.1$ km

$\theta = 9.7$ rad

6. $v = r\omega$

(a) $r = 8.7$ m

$\omega = 3.0$ rad/sec

(b) $r = 6.2$ ft

$\omega = 1.3$ rad/sec

In Exercises 7–10, convert from miles per hour to feet per second or from feet per second to miles per hour.

7. 60 mph

8. 45 mph

9. 8.8 ft/sec

10. 132 ft/sec

SECTION 4.1 EXERCISES

In Exercises 1–4, convert from DMS to decimal form.

1. $23^\circ 12'$

2. $35^\circ 24'$

3. $118^\circ 44' 15''$

4. $48^\circ 30' 36''$

In Exercises 5–8, convert from decimal form to degrees, minutes, seconds (DMS).

5. 21.2°

6. 49.7°

7. 118.32°

8. 99.37°

In Exercises 9–16, convert from DMS to radians.

9. 60°

10. 90°

11. 120°

12. 150°

13. 71.72°

14. 11.83°

15. $61^\circ 24'$

16. $75^\circ 30'$

In Exercises 17–24, convert from radians to degrees.

17. $\pi/6$

18. $\pi/4$

19. $\pi/10$

20. $3\pi/5$

21. $7\pi/9$

22. $13\pi/20$

23. 2

24. 1.3

In Exercises 25–32, use the appropriate arc length formula to find the missing information.

s	r	θ
25. ?	2 in.	25 rad
26. ?	1 cm	70 rad

27. 1.5 ft ? $\pi/4$ rad

28. 2.5 cm ? $\pi/3$ rad

29. 3 m 1 m ?

30. 4 in. 7 in. ?

31. 40 cm ? 20°

32. ? 5 ft 18°

In Exercises 33 and 34, a central angle θ intercepts arcs s_1 and s_2 on two concentric circles with radii r_1 and r_2 respectively. Find the missing information.

θ	r_1	s_1	r_2	s_2
33. ?	11 cm	9 cm	44 cm	?
34. ?	8 km	36 km	?	72 km

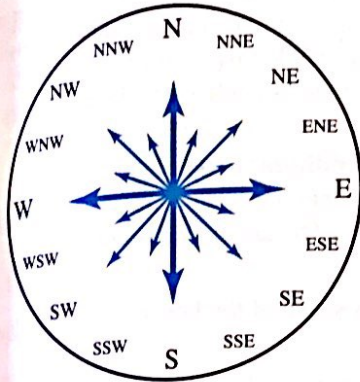
35. To the nearest inch, find the perimeter of a 10-degree sector cut from a circular disc of radius 11 inches.

36. A 100-degree arc of a circle has a length of 7 cm. To the nearest centimeter, what is the radius of the circle?

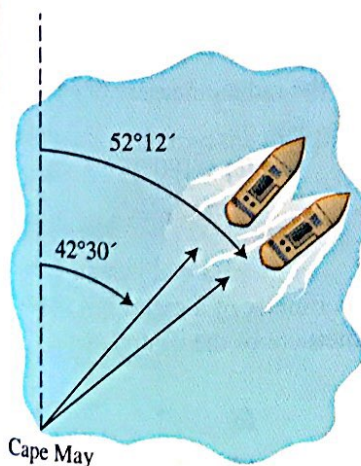
37. It takes ten identical pieces to form a circular track for a pair of toy racing cars. If the inside arc of each piece is 3.4 inches shorter than the outside arc, what is the width of the track?

38. The concentric circles on an archery target are 6 inches apart. The inner circle (red) has perimeter of 37.7 inches. What is the perimeter of the next-largest (yellow) circle?

Exercises 39–42 refer to the 16 compass bearings shown. North corresponds to an angle of 0° , and other angles are measured clockwise from north.



39. **Compass Reading** Find the angle in degrees that describes the compass bearing.
- NE (northeast)
 - NNE (north-northeast)
 - WSW (west-southwest)
40. **Compass Reading** Find the angle in degrees that describes the compass bearing.
- SSW (south-southwest)
 - WNW (west-northwest)
 - NNW (north-northwest)
41. **Compass Reading** Which compass direction is closest to a bearing of 121° ?
42. **Compass Reading** Which compass direction is closest to a bearing of 219° ?
43. **Navigation** Two Coast Guard patrol boats leave Cape May at the same time. One travels with a bearing of $42^\circ 30'$ and the other with a bearing of $52^\circ 12'$. If they travel at the same speed, approximately how far apart will they be when they are 25 statute miles from Cape May?



44. **Automobile Design** Table 4.1 shows the size specifications for the tires that come as standard equipment on three different American vehicles:

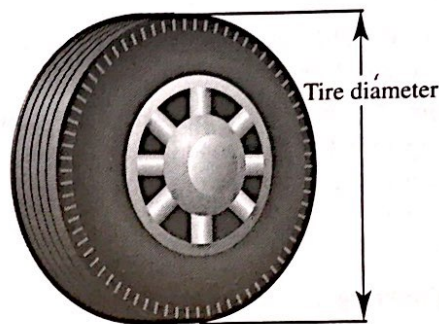


TABLE 4.1 TIRE SIZE SPECIFICATIONS FOR THREE AMERICAN VEHICLES

Vehicle	Tire Type	Tire diameter
Ford Taurus	215/60-16	26.16 inches
Chevrolet Camaro	235/55-16	26.18 inches
Dodge Dakota R/T	255/55-17	28.04 inches

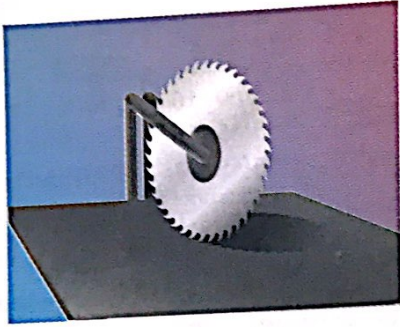
Source: www.tirerack.com

- Find the speed of each vehicle in mph when the wheels are turning at 800 revolutions per minute.
- Compared to the Dodge Dakota, how many more revolutions must the tires of the Ford Taurus make in order to travel a mile?
- Writing to Learn** It is unwise (and in some cases illegal) to equip a vehicle with wheels of a larger diameter than those for which it was designed. If a 2002 Ford Taurus were equipped with 28-inch tires, how would it affect the odometer (which measures mileage) and speedometer readings?

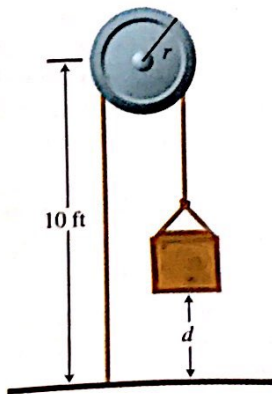


45. **Bicycle Racing** Cathy Nguyen races on a bicycle with 13-inch radius wheels. When she is traveling at a speed of 44 ft/sec, how many revolutions per minute are her wheels making?
46. **Tire Sizing** The numbers in the “tire type” column in Exercise 44 give the size of the tire in the P-metric system. Each number is of the form $W/R-D$, where W is the width of the tire in millimeters, $R/100$ is the ratio of the sidewall (S) of the tire to its width W , and D is the diameter (in inches) of the wheel without the tire.
- Show that $S = WR/100$ millimeters $= WR/2540$ inches.
 - The tire diameter is $D + 2S$. Derive a formula for the tire diameter that only involves the variables D , W , and R .
 - Use the formula in (b) to verify the tire diameters in Exercise 44. Then find the tire diameter for the 2002 Toyota Camry, which comes with 205/65-15 tires.

47. **Tool Design** A radial arm saw has a circular cutting blade with a diameter of 10 inches. It spins at 2000 rpm. If there are 12 cutting teeth per inch on the cutting blade, how many teeth cross the cutting surface each second?



48. **Navigation** Sketch a diagram of a ship on the given course.
 (a) 35° (b) 128° (c) 310°
49. **Navigation** The captain of the tourist boat *Julia* out of Oak Harbor follows a 38° course for 2 miles and then changes to a 47° course for the next 4 miles. Draw a sketch of this trip.
50. **Navigation** Points *A* and *B* are 257 nautical miles apart. How far apart are *A* and *B* in statute miles?
51. **Navigation** Points *C* and *D* are 895 statute miles apart. How far apart are *C* and *D* in nautical miles?
52. **Designing a Sports Complex** Example 4 describes how lanes 1 and 2 compare in length around one turn of a track. Find the differences in the lengths of these lanes around one turn of the same track.
 (a) Lanes 5 and 6 (b) Lanes 1 and 6
53. **Mechanical Engineering** A simple pulley with the given radius r used to lift heavy objects is positioned 10 feet above ground level. Given that the pulley rotates θ° , determine the height to which the object is lifted.
 (a) $r = 4$ in., $\theta = 720^\circ$ (b) $r = 2$ ft, $\theta = 180^\circ$



54. **Foucault Pendulum** In 1851 the French physicist Jean Foucault used a pendulum to demonstrate the Earth's rotation. There are now over 30 Foucault pendulum displays in the United States. The Foucault pendulum at the Smithsonian Institution in Washington, D.C., consists of a large brass ball suspended by a thin 52-foot cable. If the ball swings through an angle of 1° , how far does it travel?
55. **Group Activity Air Conditioning Belt** The belt on an automobile air conditioner connects metal wheels with radii $r = 4$ cm and $R = 7$ cm. The angular speed of the larger wheel is 120 rpm.
 (a) What is the angular speed of the larger wheel in radians per second?
 (b) What is the linear speed of the belt in centimeters per second?
 (c) What is the angular speed of the smaller wheel in radians per second?
56. **Group Activity Ship's Propeller** The propellers of the *Amazon Paradise* have a radius of 1.2 m. At full throttle the propellers turn at 135 rpm.
 (a) What is the angular speed of a propeller blade in radians per second?
 (b) What is the linear speed of the tip of the propeller blade in meters per second?
 (c) What is the linear speed (in meters per second) of a point on a blade halfway between the center of the propeller and the tip of the blade?

Standardized Test Questions

57. **True or False** If horse *A* is twice as far as horse *B* from the center of a merry-go-round, then horse *A* travels twice as fast as horse *B*. Justify your answer.
58. **True or False** The radian measure of all three angles in a triangle can be integers. Justify your answer.
- You may use a graphing calculator when answering these questions.

59. **Multiple Choice** What is the radian measure of an angle of x degrees?
 (a) πx (b) $x/180$
 (c) $\pi x/180$ (d) $180x/\pi$
 (e) $180/x\pi$
60. **Multiple Choice** If the perimeter of a sector is 4 times its radius, then the radian measure of the central angle of the sector is
 (a) 2 (b) 4
 (c) $2/\pi$ (d) $4/\pi$
 (e) impossible to determine without knowing the radius