

9.1 Circles and Circumference

Learning Target: Find the circumference of a circle.

Success Criteria:

- I can explain the relationship between the diameter and circumference of a circle.
- I can use a formula to find the circumference of a circle.

EXPLORATION 1

Using a Compass to Draw a Circle

Work with a partner. Set a compass to 2 inches and draw a circle.

- Draw a line from one side of the circle to the other that passes through the center. What is the length of the line? This is called the *diameter* of the circle.
- Estimate the distance around the circle. This is called the *circumference* of the circle. Explain how you found your answer.



EXPLORATION 2

Exploring Diameter and Circumference

Work with a partner.

- Roll a cylindrical object on a flat surface to find the circumference of the circular base.
- Measure the diameter of the circular base. Which is greater, the diameter or the circumference? how many times greater?
- Compare your answers in part (b) with the rest of the class. What do you notice?
- Without measuring, how can you find the circumference of a circle with a given diameter? Use your method to estimate the circumference of the circle in Exploration 1.



Math Practice

Calculate Accurately

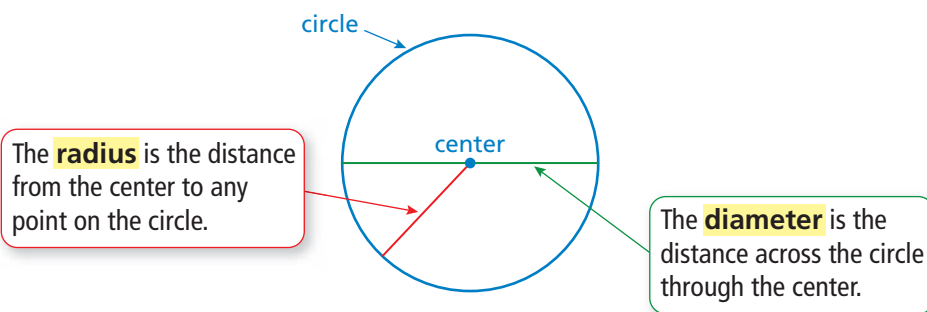
What other methods can you use to calculate the circumference of a circle? Which methods are more accurate?

9.1 Lesson

Key Vocabulary

circle, p. 362
center, p. 362
radius, p. 362
diameter, p. 362
circumference, p. 363
pi, p. 363
semicircle, p. 364

A **circle** is the set of all points in a plane that are the same distance from a point called the **center**.



Key Idea

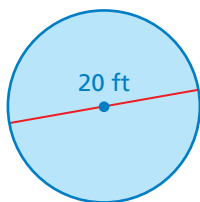
Radius and Diameter

Words The diameter d of a circle is twice the radius r . The radius r of a circle is one-half the diameter d .

Algebra **Diameter:** $d = 2r$ **Radius:** $r = \frac{d}{2}$

EXAMPLE 1 Finding a Radius and a Diameter

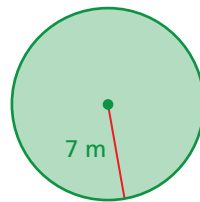
- a. The diameter of a circle is 20 feet. Find the radius.



$$\begin{aligned} r &= \frac{d}{2} && \text{Radius of a circle} \\ &= \frac{20}{2} && \text{Substitute 20 for } d. \\ &= 10 && \text{Divide.} \end{aligned}$$

▶ The radius is 10 feet.

- b. The radius of a circle is 7 meters. Find the diameter.



$$\begin{aligned} d &= 2r && \text{Diameter of a circle} \\ &= 2(7) && \text{Substitute 7 for } r. \\ &= 14 && \text{Multiply.} \end{aligned}$$

▶ The diameter is 14 meters.

Try It

1. The diameter of a circle is 16 centimeters. Find the radius.
2. The radius of a circle is 9 yards. Find the diameter.

The distance around a circle is called the **circumference**. The ratio of the circumference to the diameter is the same for *every* circle and its value is represented by the Greek letter π , called **pi**. Two approximations for the value of π are 3.14 and $\frac{22}{7}$.

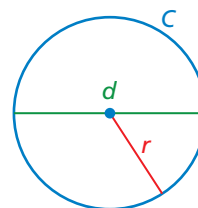
When the radius or diameter is a multiple of 7, it is easier to use $\frac{22}{7}$ as the estimate of π .

Key Idea

Circumference of a Circle

Words The circumference C of a circle is equal to π times the diameter d or π times twice the radius r .

Algebra $C = \pi d$ or $C = 2\pi r$



EXAMPLE 2 Finding Circumferences of Circles

- a. Find the circumference of the flying disc. Use 3.14 for π .



$$\begin{aligned} C &= 2\pi r && \text{Write formula for circumference.} \\ &\approx 2 \cdot 3.14 \cdot 5 && \text{Substitute 3.14 for } \pi \text{ and 5 for } r. \\ &= 31.4 && \text{Multiply.} \end{aligned}$$

▶ The circumference is about 31.4 inches.

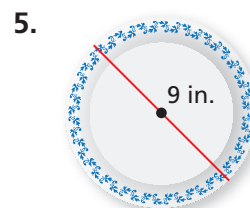
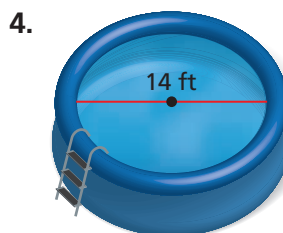
- b. Find the circumference of the watch face. Use $\frac{22}{7}$ for π .



$$\begin{aligned} C &= \pi d && \text{Write formula for circumference.} \\ &\approx \frac{22}{7} \cdot 28 && \text{Substitute } \frac{22}{7} \text{ for } \pi \text{ and 28 for } d. \\ &= 88 && \text{Multiply.} \end{aligned}$$

▶ The circumference is about 88 millimeters.

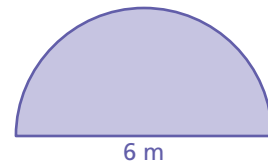
Try It Find the circumference of the object. Use 3.14 or $\frac{22}{7}$ for π .



EXAMPLE 3**Finding the Perimeter of a Semicircular Region**

A **semicircle** is one-half of a circle. Find the perimeter of the semicircular region.

The straight side is 6 meters long. The distance around the curved part is one-half the circumference of a circle with a diameter of 6 meters.



$$\frac{C}{2} = \frac{\pi d}{2}$$

Divide the circumference by 2.

$$\approx \frac{3.14 \cdot 6}{2}$$

Substitute 3.14 for π and 6 for d .

$$= \frac{18.84}{2}$$

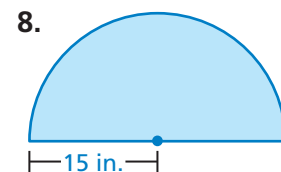
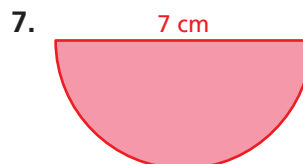
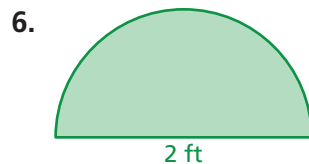
Multiply.

$$= 9.42$$

Divide.

So, the perimeter is about $6 + 9.42 = 15.42$ meters.

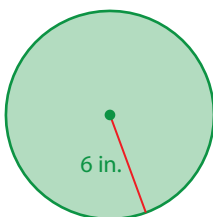
Try It Find the perimeter of the semicircular region.



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

9. **WRITING** Are there circles for which the value of the ratio of circumference to diameter is not equal to π ? Explain.
10. **FINDING A PERIMETER** Find the perimeter of a semicircular region with a straight side that is 8 yards long.
11. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.



What is the distance around the circle?

What is π times the radius?

What is the circumference of the circle?

What is π times the diameter?

EXAMPLE 4**Modeling Real Life**

The circumference of the roll of caution tape decreases 10.5 inches after a firefighter uses some of the tape. What is the radius of the roll after the firefighter uses the tape?



$$C = 31.4 \text{ in.}$$

The radius and circumference of the roll are the radius and circumference of the circular bases of the roll. After the decrease, the circumference is $31.4 - 10.5 = 20.9$ inches.

Use the formula for the circumference of a circle to find the radius of a circle with a circumference of 20.9 inches.

$$C = 2\pi r$$

Write formula for circumference.

$$20.9 \approx 2(3.14)r$$

Substitute 20.9 for C and 3.14 for π .

$$20.9 = 6.28r$$

Multiply.

$$3.3 \approx r$$

Divide each side by 6.28.

So, the radius of the roll is about 3.3 inches.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



12. The wheels of a monster truck are 66 inches tall. Find the distance the monster truck travels when the tires make one 360-degree rotation.

13. **DIG DEEPER!** The radius of a dog's collar should be at least 0.5 inch larger than the radius of the dog's neck. A dog collar adjusts to a circumference of 10 to 14 inches. Should the collar be worn by a dog with a neck circumference of 12.5 inches? Explain.



14. You resize a picture so that the radius of the midday Sun appears four times larger. How much larger does the circumference of the Sun appear? Explain.

9.1 Practice



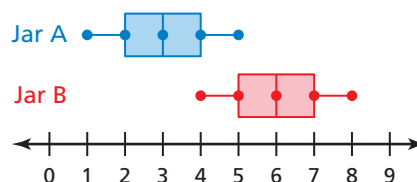
Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Two jars each contain 1000 numbered tiles. The double box-and-whisker plot represents a random sample of 10 numbers from each jar.

1. Compare the samples using measures of center and variation.
2. Can you determine which jar contains greater numbers? Explain.
3. Find the percent of change from 24 to 18.

A. 25% decrease B. 25% increase C. 75% increase D. 75% decrease



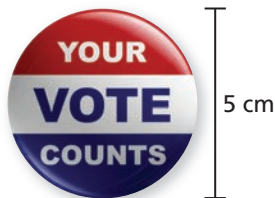
► Concepts, Skills, & Problem Solving

EXPLORING DIAMETER AND CIRCUMFERENCE Estimate the circumference of the circular base of the object. (See Exploration 2, p. 361.)

4. tube of lip balm with radius 0.5 mm
5. D battery with radius 0.65 in.

FINDING A RADIUS Find the radius of the button.

6.



7.

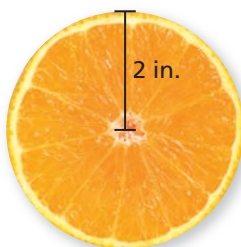


8.

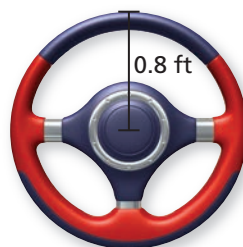


FINDING A DIAMETER Find the diameter of the object.

9.



10.



11.



FINDING A CIRCUMFERENCE Find the circumference of the object. Use 3.14 or $\frac{22}{7}$ for π .

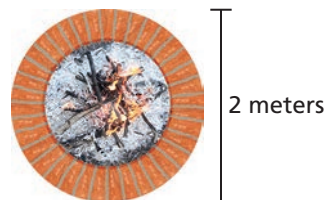
12.



13.

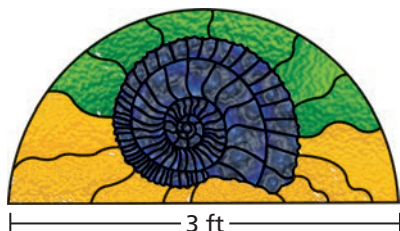


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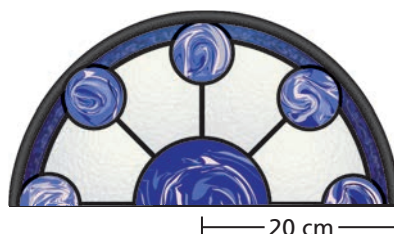


FINDING THE PERIMETER OF A SEMICIRCULAR REGION Find the perimeter of the window.

15.



16.



ESTIMATING A RADIUS Estimate the radius of the object.

17.



$C = 8.9$ mm

18.



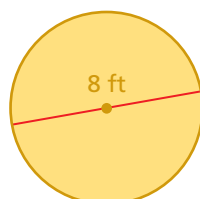
$C = 122$ in.

19. **MODELING REAL LIFE** A circular sinkhole has a circumference of 75.36 meters. A week later, it has a circumference of 150.42 meters.

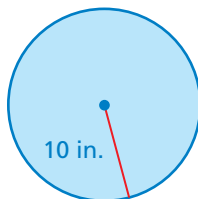
- Estimate the diameter of the sinkhole each week.
- How many times greater is the diameter of the sinkhole a week later?

20. **MP REASONING** Consider the circles A, B, C, and D.

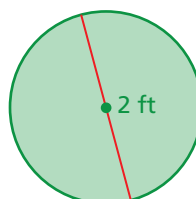
A.



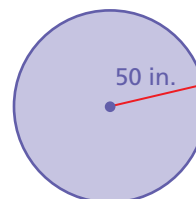
B.



C.



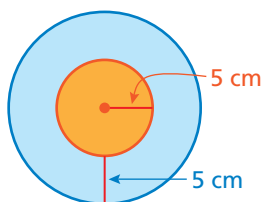
D.



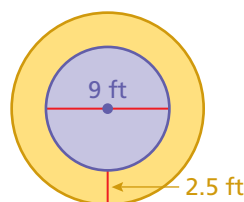
- Without calculating, which circle has the greatest circumference? Explain.
- Without calculating, which circle has the least circumference? Explain.

FINDING CIRCUMFERENCES Find the circumferences of both circles.

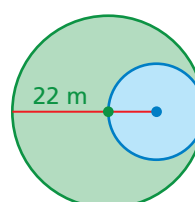
21.



22.



23.

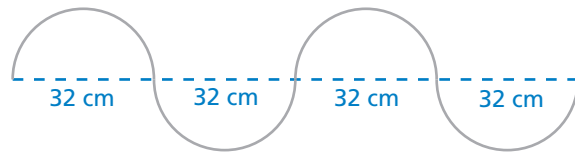


24. **MODELING REAL LIFE** A satellite is in an approximately circular orbit 36,000 kilometers from Earth's surface. The radius of Earth is about 6400 kilometers. What is the circumference of the satellite's orbit?



25. **MP STRUCTURE** The ratio of circumference to diameter is the same for every circle. Is the ratio of circumference to radius the same for every circle? Explain.

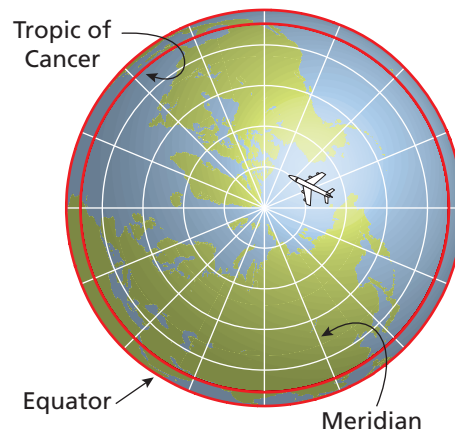
26. **MP PROBLEM SOLVING** A wire is bent to form four semicircles. How long is the wire? Justify your answer.



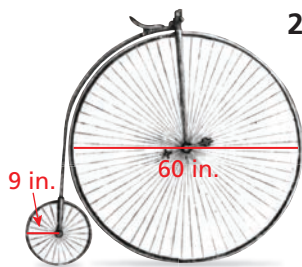
27. **CRITICAL THINKING** Explain how to draw a circle with a circumference of π^2 inches. Then draw the circle.

28. **DIG DEEPER!** “Lines” of latitude on Earth are actually circles. The Tropic of Cancer is the northernmost line of latitude at which the Sun appears directly overhead at noon. The Tropic of Cancer has a radius of 5854 kilometers.

To qualify for an around-the-world speed record, a pilot must cover a distance no less than the circumference of the Tropic of Cancer, cross all meridians, and land on the same airfield where the flight began.



- What is the minimum distance that a pilot must fly to qualify for an around-the-world speed record?
- RESEARCH** Estimate the time it will take for a pilot to qualify for the speed record. Explain your reasoning.



29. **MP PROBLEM SOLVING** Bicycles in the late 1800s looked very different than they do today.

- How many rotations does each tire make after traveling 600 feet? Round your answers to the nearest whole number.
- Would you rather ride a bicycle made with two large wheels or two small wheels? Explain.

30. **MP LOGIC** The length of the minute hand is 150% of the length of the hour hand.

- What distance will the tip of the minute hand move in 45 minutes? Justify your answer.
- In 1 hour, how much farther does the tip of the minute hand move than the tip of the hour hand? Explain how you found your answer.

