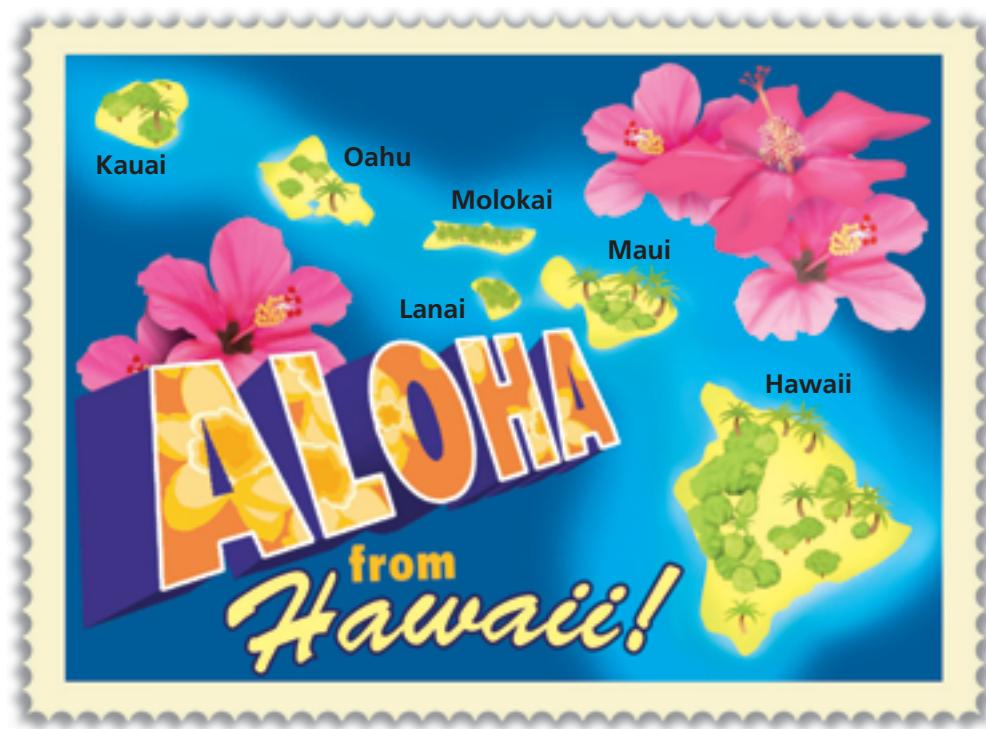


# Measuring Irregular Shapes and Circles

It is not hard to find the area and perimeter of shapes made from straight lines. These shapes include rectangles, triangles, and parallelograms. But measuring the area and perimeter of shapes made from curved lines is not always as easy.

You encounter circles every day in tools, toys, vehicles, bottle caps, compact discs, coins, and so on. Irregular shapes are also all around you. The shorelines and the shapes of lakes and islands are usually curvy, or irregular. Cartographers, or mapmakers, often work with irregular shapes such as those of the islands that form the state of Hawaii.



Because you do not have rules for finding areas and perimeters of shapes with curved edges, you can only estimate. You will develop good estimating skills to compare areas. You will then find more accurate ways to measure the area and the perimeter of some shapes with curved edges.

## 5.1

## Measuring Lakes

Geographers must know the scale of the picture to estimate the area and perimeter of a lake from a picture.

To estimate perimeter, they can

- Lay a string around the lake's shoreline in the picture of the lake.
- Measure the length of the string.
- Scale the answer.

To estimate area, they can

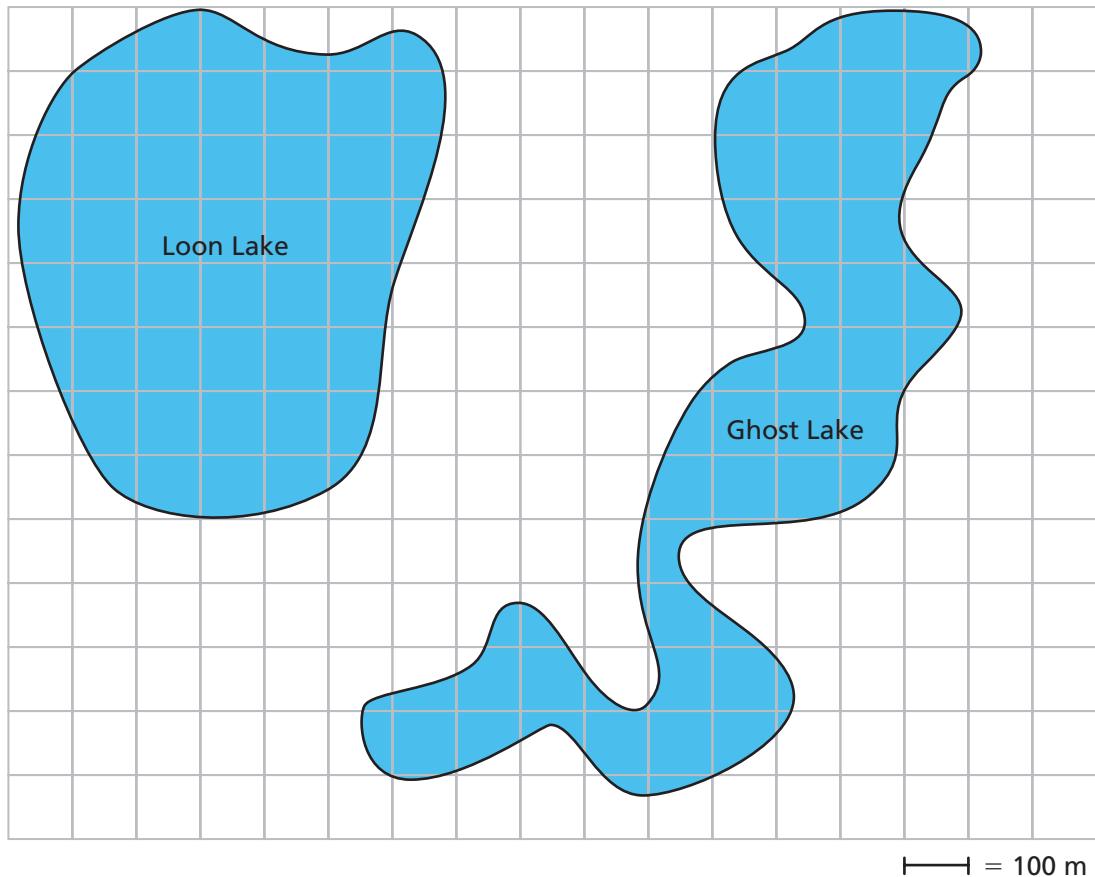
- Put a transparent grid over the picture of the lake.
- Count the number of unit squares needed to cover the picture.
- Use the scale of the picture to tell what the count means.



The state Parks and Recreations Division bought a property containing Loon Lake and Ghost Lake. Park planners will develop one lake for swimming, fishing, and boating. The other lake will be used as a nature preserve for hiking, camping, and canoeing. Planners have to think about many things when deciding how to use a lake. The perimeter, area, and shape of the lake influence their decisions.

## Problem 5.1 Estimating Perimeter and Area

Scale pictures for Loon Lake and Ghost Lake are on the grid.



- A.** Estimate the area and perimeter of Loon Lake and Ghost Lake.
- B.** Which lake is larger? Explain your reasoning.
- C.** Use your estimates to answer the questions. Explain your answers.
  - 1.** Naturalists claim that water birds need long shorelines for nesting and fishing. Which lake will better support water birds?
  - 2.** Sailboaters and waterskiers want a lake with room to cruise. Which lake works better for boating and skiing?
  - 3.** Which lake has more space for lakeside campsites?
  - 4.** Which lake is better for swimming, boating, and fishing? Which lake is better for the nature preserve?
- D. 1.** Is your estimate of the area of each lake more or less than the actual area of that lake? Explain.
- 2.** How could you get a more accurate estimate?

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## Did You Know?

In the upper Midwest of the United States, there is concern that the level of water in the Great Lakes is decreasing. The lakes get smaller as a result. The United States Great Lakes Shipping Association reports that for every inch of lost clearance due to low water, a vessel loses from 90 to 115 metric tons of cargo-carrying capacity.

In the year 2000, the water level in the Great Lakes decreased. Carriers that transported iron ore, coal, and other raw cargoes had to reduce their carrying load by 5 to 8 percent. Prices for these items increased as a result.



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For: Information about the Great Lakes

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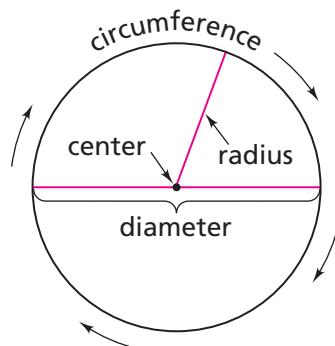
## 5.2

## Surrounding a Circle

The most popular shape for pizzas is a circle. The size of a pizza is usually given by its diameter. The **diameter** of a circle is any line segment from a point on a circle through the center to another point on the circle.

Radius, area, and circumference are also useful for describing the size of a circle. A **radius** is any line segment from the center of a circle to a point on the circle.

**Circumference** means perimeter in the language of circles. It is the distance around the circle. And, of course, area is a measure of how many square units it takes to exactly cover the region inside the circle.



As you work with circular objects in this investigation, look for connections among a circle's diameter, radius, area, and circumference.

### Getting Ready for Problem 5.2

Many pizza restaurants sell small, medium, and large pizzas. Of course, the prices are different for the three sizes.

- How do pizza makers determine the price of a pizza? Do you think a large pizza is usually the best buy?

In addition to pricing pizza, pizza makers also need to look for new ways to sell pizzas. One innovation is a pizza with cheese baked into the rim of the crust. To determine the price of these new pizzas, the pizza maker needs to know the length of the rim for each pizza. The length of the rim of crust is the circumference of the pizza.

### Problem 5.2 Finding Circumference

When you want to find out if measurements are related, looking at patterns from many examples will help.

- Use a tape measure or string to measure the circumference and diameter of several different circular objects. Record your results in a table with columns for the object, diameter, and circumference.
- Study your table. Look for patterns and relationships between the circumference and the diameter. Test your ideas on some other circular objects.
  - Can you find the circumference of a circle if you know its diameter? If so, how?
  - Can you find the diameter of a circle if you know its circumference? If so, how?

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## 5.3

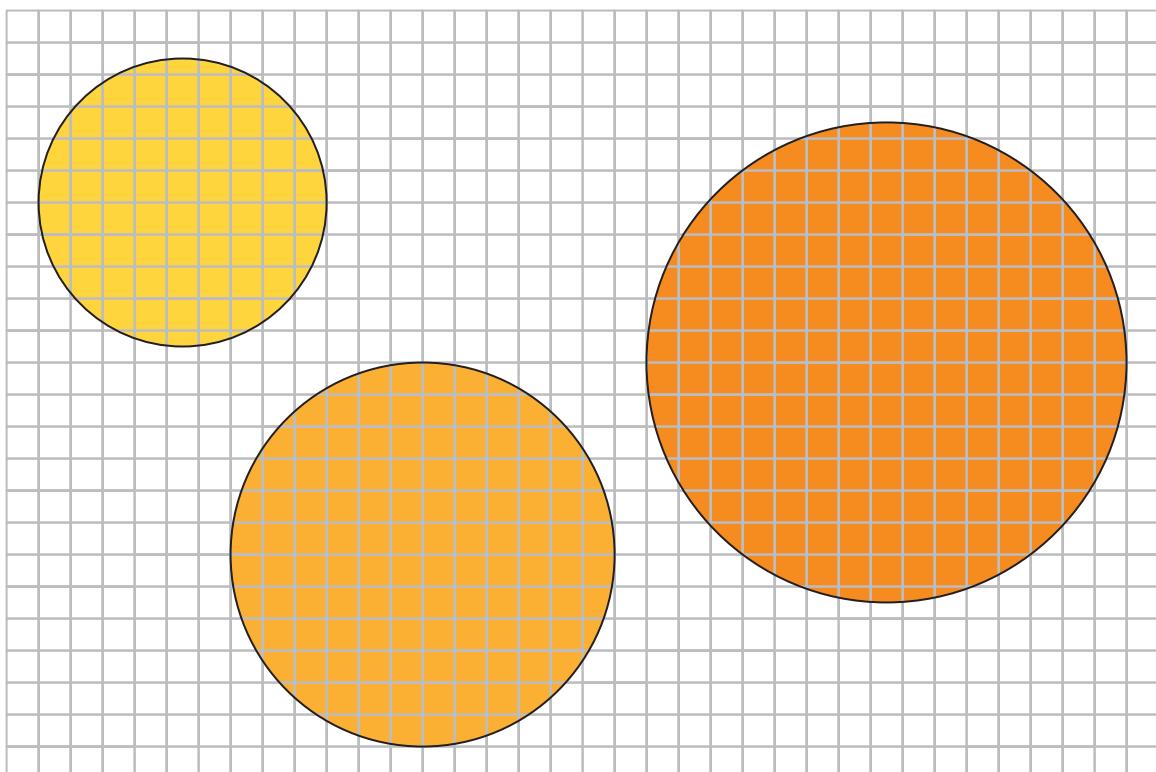
## Pricing Pizzas

In the last problem, you found a pattern that was helpful in finding the circumference of a circle.

*Do you think there is a similar pattern for finding the area of a circle?*

A pizzeria decides to sell three sizes of its new pizza. A small pizza is 9 inches in diameter, a medium is 12 inches in diameter, and a large is 15 inches in diameter.

The owner surveyed her lunch customers to find out what they would be willing to pay for a small pizza. She found that \$6 was a fair price for a 9-inch pizza with one topping. Based on this price, the owner wants to find fair prices for 12- and 15-inch pizzas with one topping. She uses the scale models of the different size pizzas on grid paper shown below.



$\square = 1 \text{ inch}$

### Problem 5.3 Exploring Area and Circumference

- A. Find as many different ways as you can to estimate the area of the pizzas. For each method, give your estimate for the area and describe how you found it.
- B. Copy the table and record each pizza's size, diameter, radius, circumference, and area in a table.

Size	Diameter	Radius	Circumference	Area
Small	■	■	■	■
Medium	■	■	■	■
Large	■	■	■	■

- C. Examine the data in the table and your strategies for finding area. Describe any shortcuts that you found for finding the area of a circle.
- D. In your opinion, should the owner of the pizzeria base the cost of a pizza on area or on circumference? Explain.

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## Did You Know?

You have discovered that the circumference of a circle is a little more than three times the diameter. There is a special name given to this number.

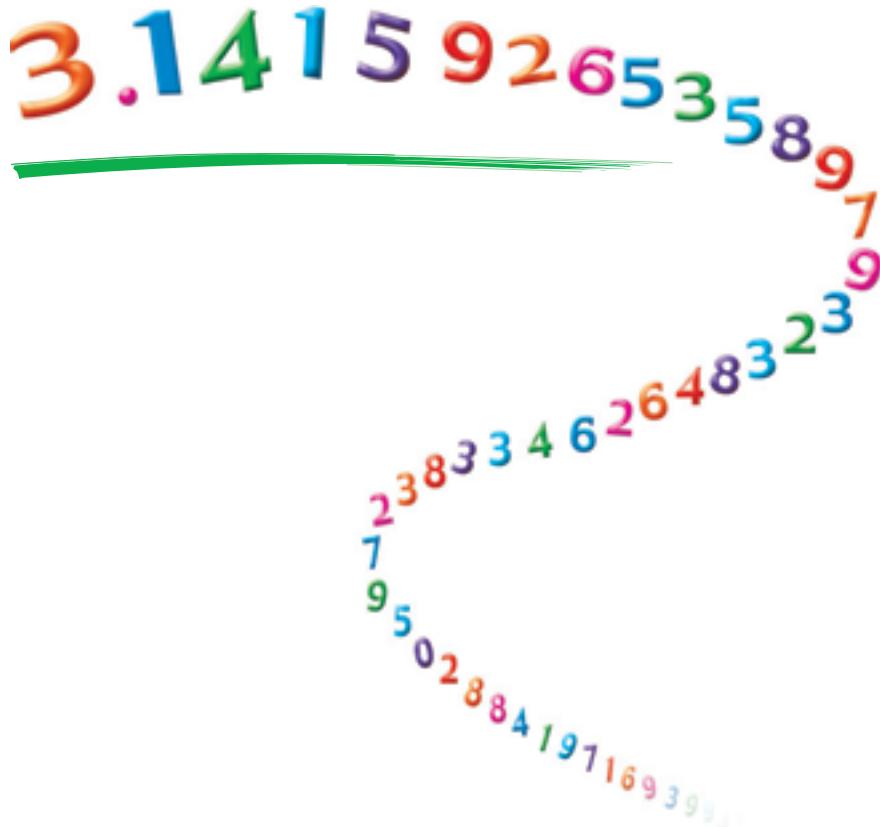
In 1706, William Jones used the Greek letter for  $\pi$  (also written as **pi**, and pronounced “pie”) to represent this number. He used the symbol to stand for the distance around a circle with a diameter of 1 unit.

As early as 2000 B.C., the Babylonians knew that  $\pi$  was more than 3. Their estimate for  $\pi$  was  $3\frac{1}{8}$ . By the fifth century, Chinese mathematician Tsu Chung-Chi wrote that  $\pi$  was somewhere between 3.1415926 and 3.1415927. From 1436 to 1874, the known value of  $\pi$  went from 14 places past the decimal point to 707 places.

We have used computers to calculate millions more digits. Mathematicians have shown that  $\pi$  cannot be expressed as a fraction with whole numbers in the numerator and denominator. Numbers having decimal representations that never come out “even” and have no repeating pattern are called *irrational numbers*.



For: Information about pi  
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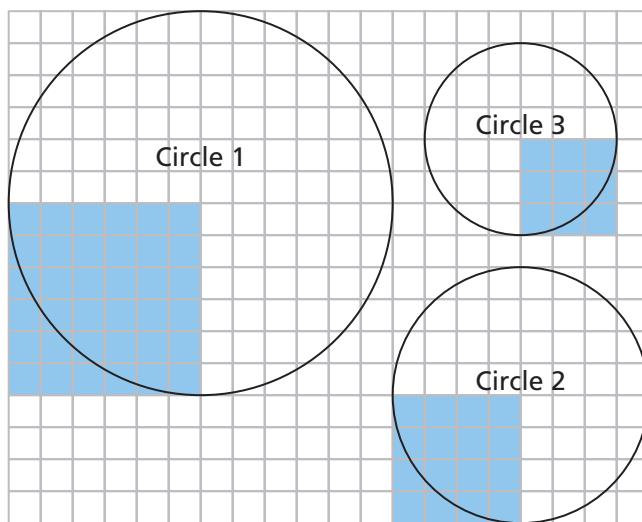
## 5.4

## “Squaring” a Circle

Earlier you developed formulas for the area of triangles and parallelograms by comparing them to rectangles. Now you can find out more about the area of circles by comparing them to squares.

### Problem 5.4 Finding Area

A portion of each circle is covered by a shaded square. The length of a side of the shaded square is the same length as the radius of the circle. We call such a square a “radius square.”



- A.** How many radius squares does it take to cover the circle? (You can cut out radius squares, cover the circle and see how many it takes to cover.)

Record your data in a table with columns for circle number, radius, area of the radius square, area of the circle, and number of radius squares needed.

- B.** Describe any patterns and relationships you see in your table that will allow you to predict the area of the circle from its radius square. Test your ideas on some other circular objects.
- C.** How can you find the area of a circle if you know the radius?
- D.** How can you find the radius of a circle if you know the area?

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