

# Chapter 3

## Length, Area, and Volume



*Kristi Hansen is a Red Seal plumber. Calculating the capacity of water lines, determining the length of pipe needed for drainage systems, and accurately predicting the volume of hot water a building's system will use are some of her tasks.*

### 3.1

## Systems of Measurement

### REVIEW: WORKING WITH PERIMETER

**perimeter:** the sum of the lengths of all the sides of a polygon

In this section, you will calculate the **perimeter** of different shapes.

A square is a quadrilateral with 4 equal sides, so the perimeter can be found by the following formula:

$$P = 4 \times (\textit{side length})$$

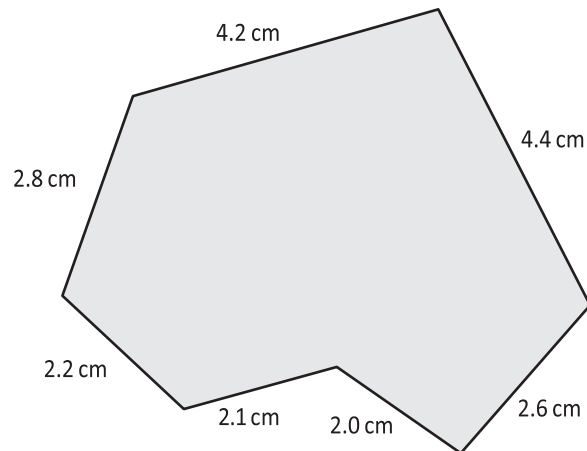
The perimeter of a rectangle with length  $\ell$  and width  $w$  can be found by the following formula:

$$P = 2\ell + 2w$$

$$P = 2(\ell + w)$$

**Example 1**

What is the perimeter of this figure?

**SOLUTION**

This figure is a heptagon, which means it has 7 sides. Its perimeter,  $P$ , is the sum of the lengths of all 7 sides.

$$P = 2.8 + 4.2 + 4.4 + 2.6 + 2.0 + 2.1 + 2.2$$

$$P = \underline{\hspace{2cm}} \text{ cm}$$

When the units of measurement are all the same, you can ignore them during calculations. Remember to add the units in at the end.

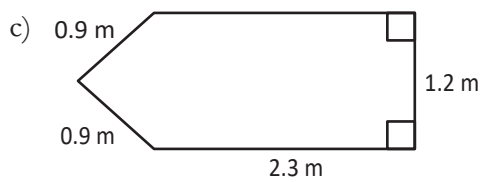
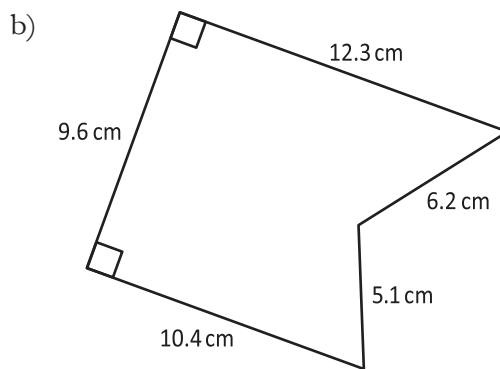
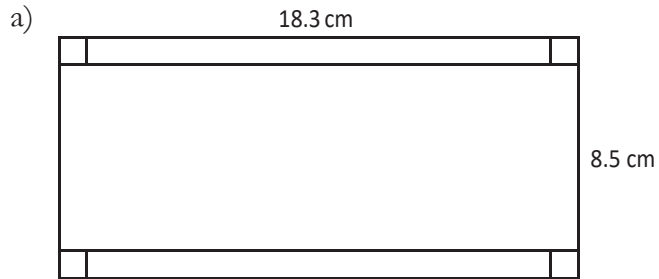
To make sure that you don't miss any sides when calculating the perimeter of a figure, start at one vertex and work your way around the figure.

The perimeter is                                  cm.

**BUILD YOUR SKILL**

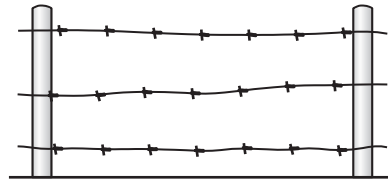
A small square symbol in the corner of a diagram means that it is a right angle.

1. Calculate the perimeters of the following diagrams.



2. Darma is edging a tablecloth with lace. The tablecloth is 210 cm by 180 cm. How much lace does she need?

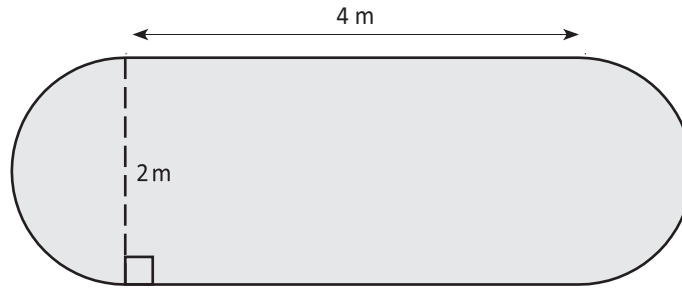
3. Garry installs a wire fence around a rectangular pasture. The pasture measures 15 m by 25 m, and he uses three rows of barbed wire. How much wire did he use?



4. Chantal is building a fence around her swimming pool. The pool is 25 ft long and 12 ft wide, and she wants a 6-ft wide rectangular walkway around the entire pool. How much fencing will she need?

**Example 2**

The sides of the flower garden shown below are 4 m long. Each end is a semi-circle with a diameter of 2 m. What is the perimeter of the flower garden?

**SOLUTION**

Break this problem down into two parts, a circle and a rectangle.

If you add the two end sections together, they form a circle. You can use the formula for the **circumference** to find the perimeter:

$$C = \pi d \text{ or } 2\pi r$$

$C$  is the circumference,  $r$  is the radius,  $d$  is the diameter, and  $\pi$  is a constant. In this example, the diameter is 2 m.

Find the circumference of the ends of the flower garden by using this formula.

$$C = \pi d$$

$$C = \underline{\hspace{2cm}}$$

$$C \approx \underline{\hspace{2cm}}$$

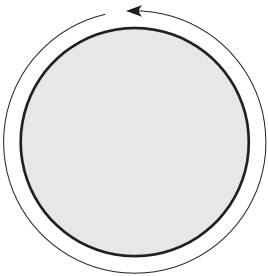
Add the lengths of the two straight parts to the circumference of the circle to calculate the perimeter.

$$P \approx 6.28 + \underline{\hspace{2cm}} + \underline{\hspace{2cm}}$$

$$P \approx \underline{\hspace{2cm}}$$

The perimeter of the flower garden is about  $\underline{\hspace{2cm}}$  m.

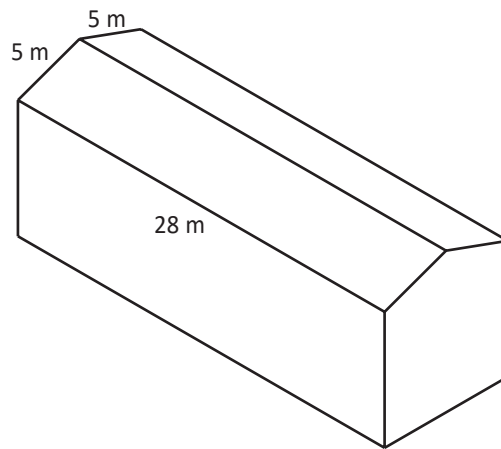
**circumference:** the measure of the perimeter of a circle



**BUILD YOUR SKILLS**

5. What is the circumference of a circular fountain if its radius is 5.3 m?

6. Johnny wants to put Christmas lights along the edge and peak of his roof. How many metres of lights will he need?



7. Hershey uses coloured wire to make a model of the Olympic symbol (5 interlocking circles). If each circle has a radius of 35 cm, how much wire does he need for the rings?

## NEW SKILLS: WORKING WITH SYSTEMS OF MEASUREMENT

**Système International (SI):** the modern version of the metric system; uses the metre as the basic unit of length

**imperial system:** the system most commonly used in the United States; the standard unit of measurement for length is the foot

Although there are other systems of measurement, the two most common are the **Système International (SI)** and the **imperial system**. In Canada, the official system of measurement is the SI. Because of Canada's close proximity to the United States, you should be familiar with both systems. Both are used in certain contexts.

Below are listed some common imperial units of length and their relationships.

$$12 \text{ inches (in or ") = 1 foot (ft or ')}$$

$$36 \text{ inches = 1 yard (yd)}$$

$$3 \text{ feet = 1 yard}$$

$$5280 \text{ feet = 1 mile (mi)}$$

$$1760 \text{ yards = 1 mile}$$

For more details, see page 94 of *MathWorks 10*.

### Example 3

Wilhelmina, a seamstress, is sewing bridesmaids' dresses. She orders the fabric from the United States, where fabric is measured in yards. Each dress requires  $3\frac{3}{4}$  yards of silk, 1.5 yards of lace fabric, and  $7\frac{1}{4}$  yards of trim. How much of each type of material does Wilhelmina need to make 5 dresses?

#### SOLUTION

Convert each mixed fraction to a decimal, and then multiply by 5.

$$\text{silk} = 3\frac{3}{4}$$

$$\text{silk} = 3.75$$

$$\text{silk} = 3.75 \times 5 = 18.75$$

$$\text{lace fabric} = 1\frac{1}{2}$$

$$\text{lace fabric} = 1.5$$

$$\text{lace fabric} = 1.5 \times 5 \text{ lace fabric} = 7.5$$

$$\text{trim} = 7\frac{1}{4}$$

$$\text{trim} = 7.25$$

$$\text{trim} = 7.25 \times 5 = 36.25$$

Since fabric can be bought in partial yards, Wilhelmina will need to purchase \_\_\_\_\_ yd of silk, \_\_\_\_\_ yd of lace fabric, and \_\_\_\_\_ yd of trim.

If you look at a ruler marked in imperial units, you will notice that it is usually divided into halves, quarters, eighths, and sixteenths, whereas the SI system uses tenths.

**BUILD YOUR SKILL**

A 2 by 4 is not exactly 2" by 4".

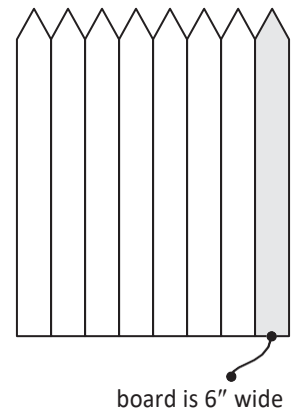
The name comes from the dimensions of the lumber before it is dried; when the lumber dries, it shrinks and then is replaned to make it a standard size.

A 2 by 4 is actually

$1\frac{1}{2}$ " by  $3\frac{1}{2}$ ".

Lumber and other building supplies are usually sold using imperial units.

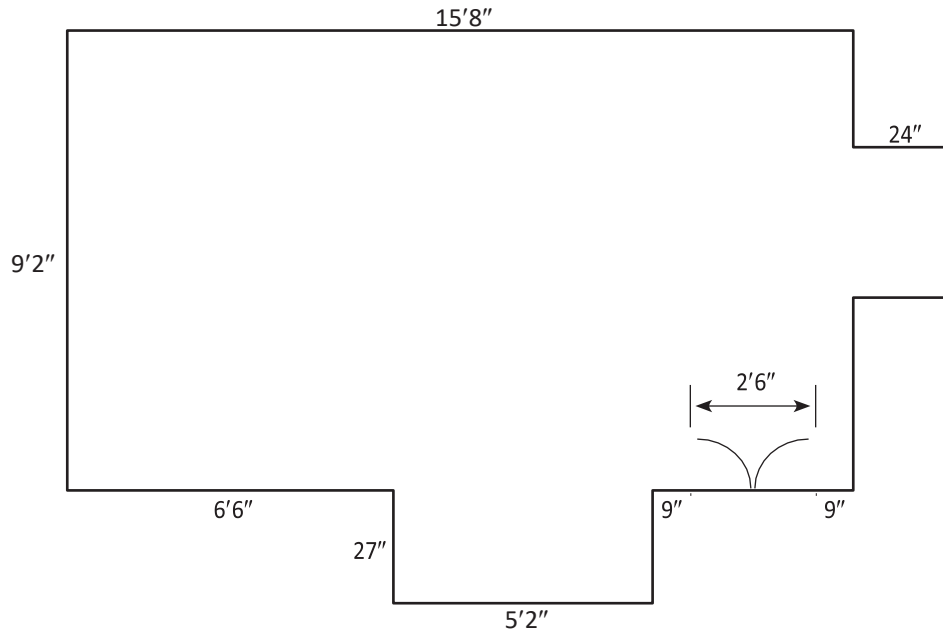
8. Bernard is buying some lumber to finish a project. He needs 3 pieces of 2 by 4 that are each  $4\frac{1}{2}$  feet long, and 10 pieces of 2 by 2 that are each  $5\frac{1}{4}$  feet long. How much of each does he need in total?
9. Benjie is replacing some plumbing pipes. He needs 3 pieces of copper pipe: one piece is 2 feet long, one is 5 feet 7 inches long, and one is 4 feet long. How much copper pipe does he need if he loses 1 inch when he cuts the pipe and he can only buy it in even numbers of feet?
10. If each board in a fence is 6 inches wide, how many of them will José need to fence a playground that is 60 feet wide by 125 feet long?





**Example 4**

Fatima is trying to calculate how much baseboard she will need for the room shown below.



What is the minimum amount of baseboard she will need?

**SOLUTION**

Find the perimeter of the room. Since there is a door, no baseboard will be needed there. Measurements are given in feet and/or inches.

To find the perimeter of the room, start at any one point, such as the edge of the door, and work your way around the room.

$P =$

Where did the second 9'2" come from?

Therefore, she needs \_\_\_\_\_ of baseboard.

**BUILD YOUR SKILLS**

11. A pet shop stores 5 pet cages that are 2'8" wide, 3 cages that are 4'6" wide, and 2 cages that are 1'8" wide. Can these cages fit side by side along a wall that is 30' long?
12. A circular garden is 6'4" in diameter. To plant a geranium approximately every foot along the circumference, how many geraniums are needed?
13. The height of a basement ceiling is 7'2". A 6"-deep heating pipe runs across the middle. To enclose it, there must be a 1-inch space between the pipe and the drywall. Will Craig, who is 6'6" tall, be able to walk under the finished pipe?



