3 How Are Length and Volume Measured?

LESSON GOALS

You will learn
- how to measure length.
- how to measure volume.

Imagine that you have a pen pal. You want to describe yourself to this person you have never met. Think about how you would describe yourself. You might say, "I am tall." However, your pen pal could get a better idea of how tall you are if you said, "I am 140 centimeters tall." Scientists describe matter in similar ways by measuring properties of matter.

You can measure some properties. You can measure your height as the boy in the picture is doing. Before your family takes a trip, you might want to know how far you will travel. You need to know the length or distance from one place to the next. Length measures the distance between two points. You can also measure volume. Volume is the amount of space that matter takes up. When people fill their car's gas tank, they pay for the volume of gasoline they take.

Measuring height

Measuring Length

A long way means different things to a baseball player, to an airplane pilot, and to an astronaut. People need measurements in order to be clear. Every measurement includes two things—a number and a unit. "I ran 5 this morning" does not explain how far you ran. "I ran kilometers this morning" also does not explain how far you ran. "I ran 5 kilometers" is a clear measurement.

People used to measure length by comparing what they wanted to measure with the length of familiar objects. Even today you might say that your classroom is about five tables wide. However, tables come in different sizes. To be clear, scientists around the world use the same units.

A unit for measuring length is the **meter.** You would measure your classroom with a meter stick. Your meter stick is the same length as all meter sticks in the world.

In the English language, people often add a prefix to a word to change its meaning. Adding *un-* to the word *happy* changes the word's meaning. When scientists make measurements, they also use prefixes. Find the meaning of the prefixes for *meter* in the chart. How much of a meter is a **centimeter?** How much of a meter is a **millimeter?** How many meters are in a **kilometer?**

The picture shows part of a meter stick. Find the lines that stand for millimeter and centimeter. How many millimeters are in a centimeter? How many millimeters are in 10 centimeters? What is the length of the paper clip in millimeters?

meter (mē′tər), a unit for measuring length.

centimeter (sen′tə mē′tər), 1/100 of a meter.

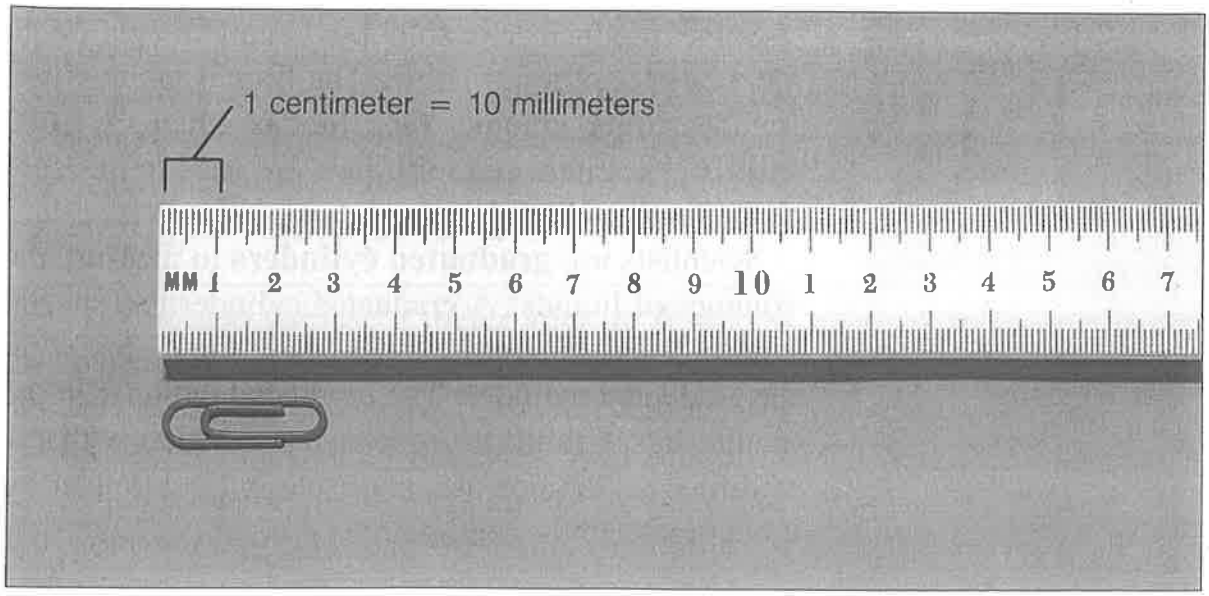
millimeter (mil′ə mē′tər), 1/1,000 of a meter.

kilometer (kə lom′ə tər), 1,000 meters.

Prefixes for *meter*

centi-	=	1/100	centimeter (cm)	=	1/100 of a meter
milli-	=	1/1,000	millimeter (mm)	=	1/1,000 of a meter
kilo-	=	1,000	kilometer (km)	=	1,000 meters

Part of a meter stick



cubic (kyü′bik) **meter,** a unit for measuring volume.

liter (lē′tər), a unit for measuring volume.

milliliter (mil′ə lē′tər), 1/1,000 of a liter.

graduated cylinder (graj′ü āt ed sil′ən dər), a piece of equipment used for measuring the volume of liquids.

Measuring Volume

Sometimes, you might want to know how much a container, such as a large box, will hold. You might guess what the volume of the box is. Your guess might be correct. However, you have a better chance of being correct if you measure the volume.

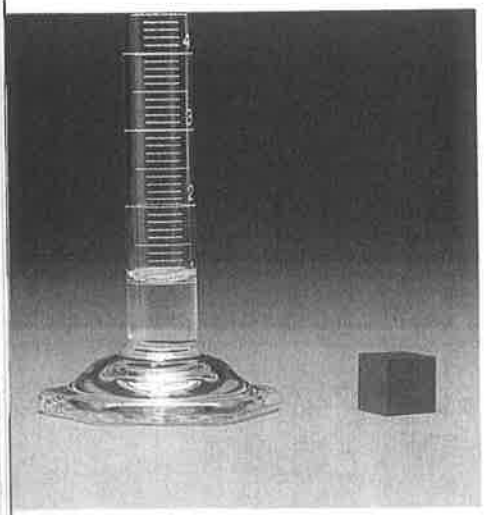
You could use an object, such as a book, to measure the volume in book units. If other people measure with a different book, they might get a different volume for the same box. Imagine you want to know how many smaller boxes would fit into the box. You would need to measure them with the same book. Scientists use the same tools and units so they can get the same measurements.

The meter stick you use to measure length can also be used to measure volume. First, measure length, width, and height. Suppose you found that the box is 2 meters long, 3 meters wide, and 1 meter high. To find the box's volume, multiply length times width times height. Multiply 2 meters × 3 meters × 1 meter. The volume of the box is 6 cubic meters. A **cubic meter** is a unit for measuring volume. One cubic meter is a cube 1 meter long, 1 meter wide, and 1 meter high. Since the box has a volume of 6 cubic meters, it can hold 6 cubes this size.

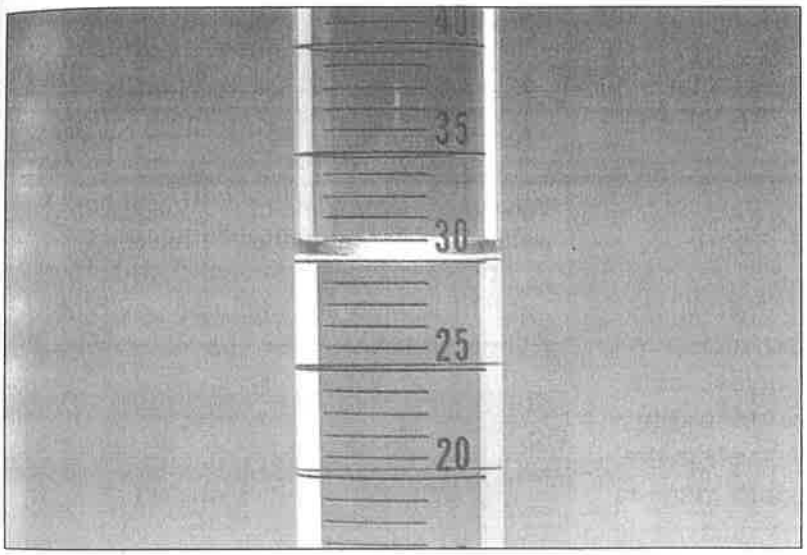
Some products are sold by volume. You might have 2-liter bottles at home. The **liter** is another unit for measuring volume. One liter is equal to 1,000 **milliliters.** Liters and milliliters are used to measure the volume of liquids.

Scientists use **graduated cylinders** to measure the volumes of liquids. A graduated cylinder is a special kind of measuring cup. Lines mark equal spaces on the graduated cylinder. The graduated cylinder in the picture has 1 milliliter of water in it. Notice that 1 milliliter is the same as a cube that is 1 centimeter by 1 centimeter by 1 centimeter.

One milliliter of water has the same volume as a cube that has a volume of 1 cubic centimeter.



Notice that the surface of the water in a graduated cylinder curves at the edges. The water climbs up the sides of the graduated cylinder a little. Measure the volume by reading the height of the liquid at the flat part. Notice that the flat part of the liquid on page 130 is at the 1 milliliter line. How many milliliters of water are in the picture below? Other liquids curve down instead of up. The flat part is above the curve.



Each line in this graduated cylinder is 1 milliliter.

SCIENCE IN YOUR LIFE

Do you usually have a quart or gallon of milk in the refrigerator at home? In the United States, many people use different units than scientists and people in other countries. Many people use cubic feet, cubic inches, cups, quarts, and gallons to measure volume. People often measure length in inches, feet, yards, or miles.

Lesson Review

1. What is a unit scientists use for measuring length?
2. What are two different units scientists use for measuring volume?
3. **Challenge!** What is the volume of a box that has a length of 5 centimeters, a width of 2 centimeters, and a height of 2 centimeters?

Study on your own, pages 384–385.

PHYSICAL SCIENCE

FIND OUT ON YOUR OWN

You also can use a meter stick to find perimeter and area. Find out what perimeter and area are. Guess the perimeter and area of different objects and places in your school. Then measure the objects and places. Record your guesses and measurements in a table.