Lesson 1
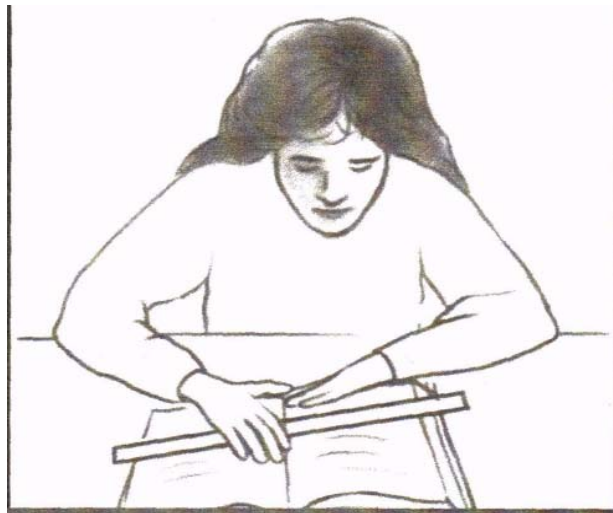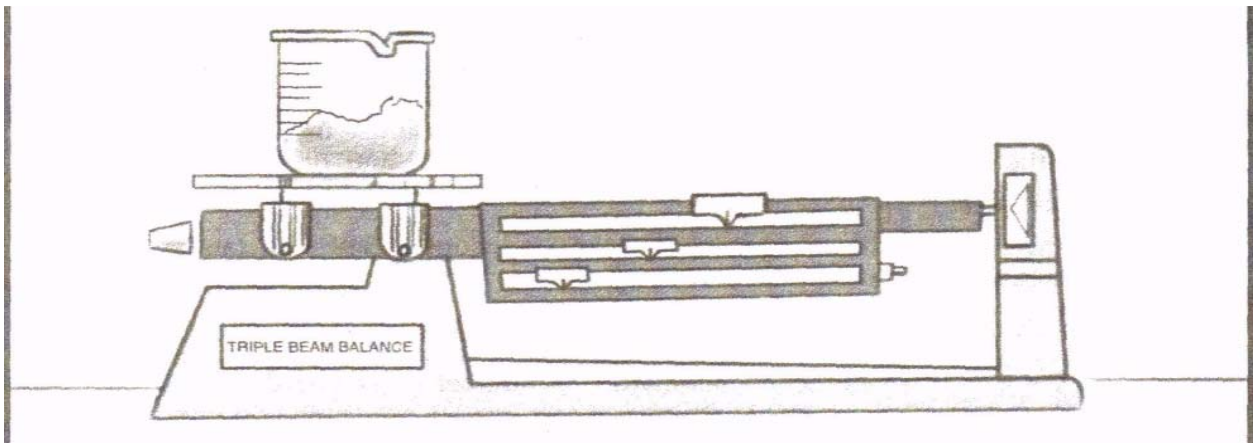
How do scientists measure things?

KEY TERMS

mass: amount of matter in an object

weight: measure of the pull of gravity on an object

length: distance between two points

area: measure of the size of a surface

volume: measure of the amount of space an object takes up

LESSON 1 | How do scientists measure things?

How much do you weigh? What is your height? How many tiles will cover your kitchen floor? How much milk should be added to a cake mix? What is the temperature outside? All of these questions are answered by measurements.

Measuring is an important part of daily life. People use measurements all the time—for shopping, cooking, construction, and deciding how warm to dress. Measuring also is an important part of science.

A measurement has two parts: a number and a unit. A unit is a standard amount used to measure something.

EXAMPLES   100   grams   25 liters

                         number standard   number   standard
                                   unit   unit

There are many kinds of measurements. The most common are:

MASS and weight are related, but they are not the same. Mass is a measure of the amount of matter in an object. Weight is a measure of the pull of gravity on an object. The basic unit of mass in the metric system is the kilogram (kg). Mass is measured with a balance.

LENGTH is the distance from one point to another as measured by a ruler. The basic metric unit of length is the meter (m). You can use a meter stick or metric ruler to measure length.

AREA is a measure of surface room—how big something is in two directions. You can find the area of a rectangle by multiplying its length by its width. Area is measured in square units, such as square meters (m^2).

VOLUME is the measure of the amount of space an object takes up—how big an object is in all three directions. The liter (L) is the basic unit of volume in the metric system. A measuring cup or a graduated cylinder is used to measure the volume of liquids.

The volume of a solid can be measured in cubic centimeters (cm^3). You can find the volume of a cube or rectangle by multiplying its length by its width by its height. 1,000 cubic centimeters equals 1 liter.

TEMPERATURE is the measure of how hot or cold an object is. Temperature is measured with a thermometer in degrees Celsius, (°C) or degrees Fahrenheit, (°F). The Celsius scale usually is used in science.

UNDERSTANDING METRICS

In the United States, people usually use <u>English</u> units of measurement such as, <u>ounces, pounds, inches,</u> and <u>feet.</u> Most other countries use metric units. Metric units include the <u>gram, kilogram, meter,</u> and <u>centimeter.</u> Scientists also use the metric system. In science, you will use mostly metric units.

The metric system is based upon units of <u>ten.</u> Each unit is ten times smaller or larger than the next unit. This means that you can convert a measurement from one unit to another by multiplying or dividing by ten. Prefixes describe a unit's value. The prefixes and their meanings are listed below.

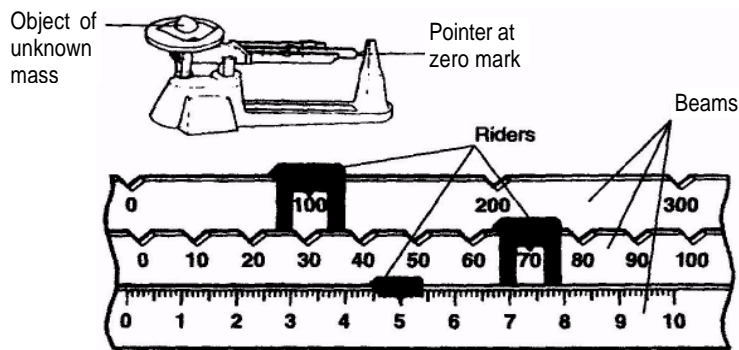| PREFIX	MEANING	
kilo- [KILL-uh]	one thousand (1,000)	
hecto- [HEC-tuh]	one hundred (100)	each, larger by
deca- [DEC-uh]	ten (10)	a multiple of
		<u>ten</u>
deci- [DESS-ih]	one tenth (1/10)	
centi- [SEN-tih]	one hundredth (1/100)	each, smaller
		by a multiple
milli- [MILL-ih]	one thousandth (1/1,000)	of 1/10

Use the chart above to answer the following questions.

1. How many grams make up a kilogram? ____ 10,100,1,000

2. How much of a meter is a centimeter? ___
    1/10,1/100,1/1,000

3. How many times larger is a hectometer compared to a decameter?
    10,100,1,000

4. How many times smaller is a millimeter compared to a decimeter?

    10,100,1,000

5. Which prefix stands for a <u>greater</u> value?

    a) deca- or kilo-? _____   d) hecto- or kilo-?

    b) kilo- or milli-? _____   e) centi- or deci-?

    c) centi- or milli-? _____   f) deca- or deci-?

MEASURING MASS

1. In the metric system, the unit of <u>mass</u> is the _____

    meter, kilogram, pound

2. Mass and weight_____ the

    Are, are not

same.

3. _____   is a measure of the amount of matter in an object.

    mass, weight

Object of unknown mass — Pointer at zero mark

Beams

Riders

0   100   200   300

0 10 20 30 40 50 60 70 80 90 100

0 1 2 3 4 5 6 7 8 9 10

Figure A

4. What instrument is used to measure mass?

5. What is the mass of the object shown? __

TRUE OR FALSE

In the space provided, write "true" if the sentence is true. Write "false" if the sentence is false.

_____   1.   Weight is a measure of the pull of gravity on an object.

_____   2.   Scientists use English units of measurement.

_____   3.   The prefix centi- stands for one hundredth (1/100).

_____   4.   A graduate is used to measure mass.

_____   5.   The basic unit of length in the metric system is the meter.

_____   6.   Volume is a measure of the amount of matter in an object.

_____   7.   One kilogram is less than one gram.

_____   8.   A measurement has two parts.

_____   9.   A unit is an amount used to measure something.

_____   10. Most countries use the metric system.

Length is measured with a metric ruler. Part of a combined metric and inch ruler is shown in Figure B. On the metric side of the ruler the distance between numbered lines is equal to one centimeter. Each centimeter is divided into 10 equal parts. Each one of these parts is equal to one millimeter.

The figure below shows a combined metric and inch ruler.
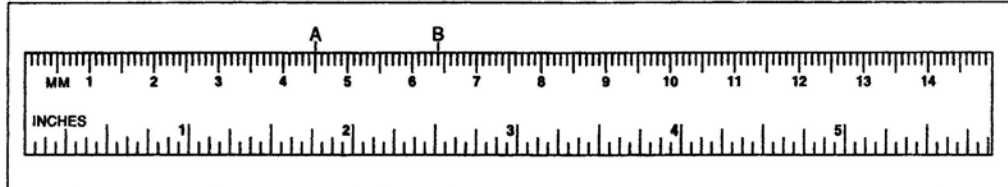
Figure B

1. What value does the prefix <u>milli-</u> stand for? _____

2. What value does the prefix <u>centi-</u> stand for? _____

3. Which is <u>larger</u>, a meter or a millimeter? _____

4. How many millimeters make 1 centimeter? _____

5. The length at A may be written as 45 mm. It may also be written as _____ .
    45 cm, 4.5 cm, 4.5 mm

6. The length at B may be written as _____ mm or _____ cm.

Measure each of the following lengths. Write the lengths on the right in centimeters and millimeters.

7. ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯   7. _____ cm _____ mm

8. ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯   8. _____ cm _____ mm

9. ⎯⎯⎯⎯⎯⎯⎯   9. _____ cm _____ mm

10. ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯   10. _____ cm _____ mm

To the right of each length listed, <u>draw</u> a line of that length.

a) 92 mm

b) 9.2 cm

c) 43 mm

d) 3.5 cm

MEASURING AREA
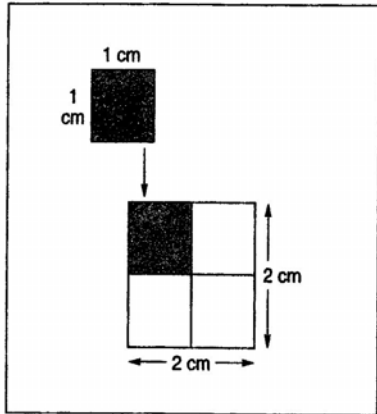
Figure C

The square in Figure C has an area of 4 square centimeters (4 cm²).

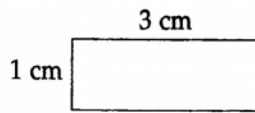$$Area = L_1 \times L_2$$

$$= 2 \text{ cm} \times 2 \text{ cm}$$

Area = 4 square centimeters (4 cm²).

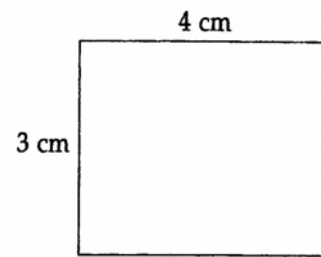*Figure the area of each of the following rectangles:* (Measure Figures G and H yourself.)
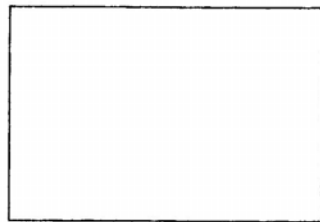
4 cm

2 cm

Figure D

_____
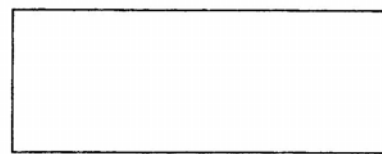
3 cm

1 cm

Figure E

_____

4 cm

3 cm
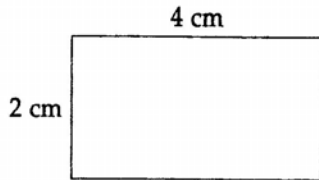
Figure F

_____

Figure G

_____

Figure H

_____

CALCULATING AREA

Find the areas of the following rectangles:

1. 5 meters × 5 meters _____

2. 2.5 cm × 5 cm _____

3. 10 millimeters × 10 millimeters _____

MEASURING VOLUME

The volume of liquids is measured in a graduated cylinder. A graduated cylinder is a glass or plastic tube that is marked with divisions to show the amount of liquid in it. To measure volume, place the graduated cylinder on a sturdy, level surface and look at the liquid at eye level. The surface of the liquid will have a "belly-down" curve. You should read the mark that lines up with the bottom of the curve.
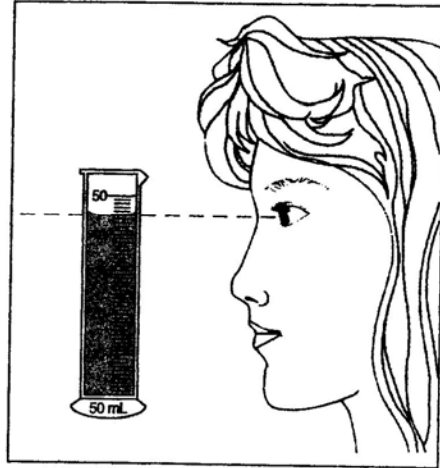
What is the liquid volume in this graduated cylinder?

_____

Figure I
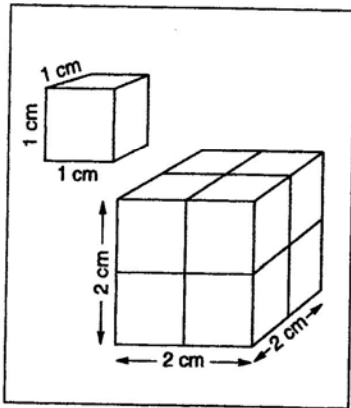
Figure J

What is the volume of a cube that is 2 cm × 2 cm × 2 cm?

Volume = $L_1 \times L_2 \times L_3$

$= 2 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm}$

Volume = 8 cubic centimeters (8 cm³).

Find the volume of each of the following rectangles:

	Volume
1. 2 cm × 5 cm × 1 cm	_____
2. 8 m × 2 m × 2 m	_____
3. 1 mm × 1 mm × 10 mm	_____
4. 4 cm × 2 cm × 3 cm	_____
5. 5 m × 3 m × 6 m	_____

READING A CELSIUS THERMOMETER

Temperature is measured with a thermometer. Many thermometers, including the ones you are most familiar with, are made of glass tubes. At the bottom of the tube is a wider part called the bulb. The bulb is filled with a liquid, such as mercury. When the bulb is heated, the liquid in the bulb expands, or gets larger. It rises in the tube. When the bulb is cooled, the liquid contracts, or gets smaller. It falls in the tube.

On the sides of a thermometer are a series of marks. You read the temperature by looking at the mark where the liquid stops.

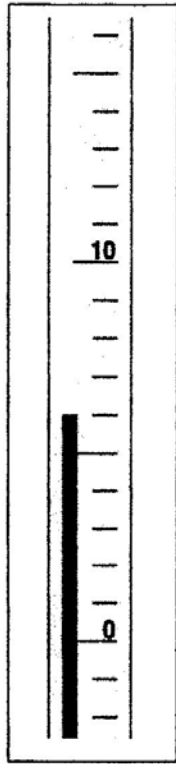*Write the temperature shown on each Celsius thermometer in the space provided.*
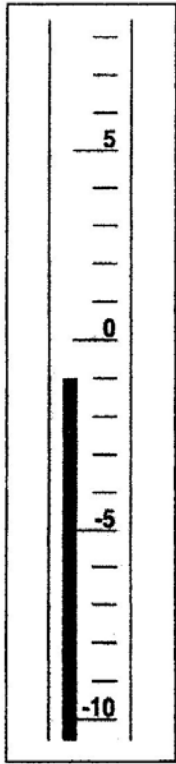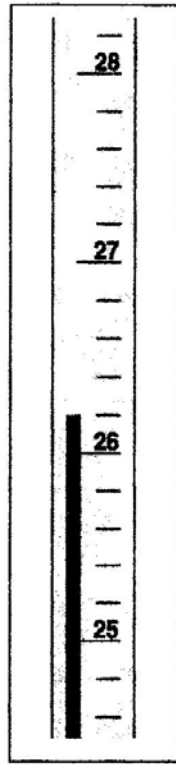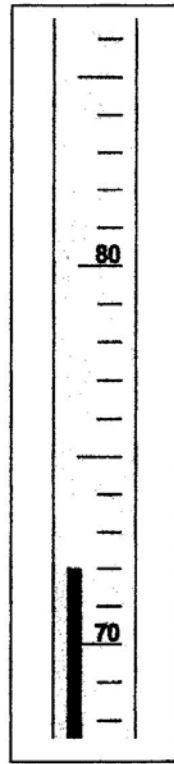
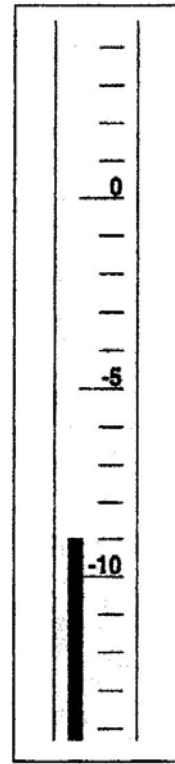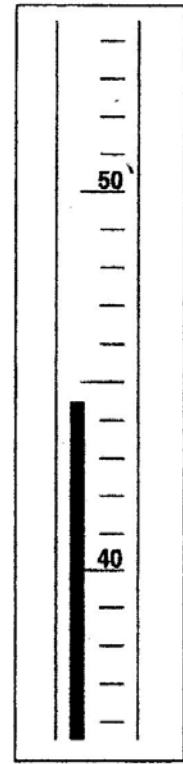| Figure K	Figure L	Figure M	Figure N	Figure O	Figure P

_____ _____ _____ _____ _____ _____

REACHING OUT

One cubic centimeter is equal to one milliliter (mL). How many <u>liters</u> of water can a 1,800 cm³ pan hold? _____