Name:

Skill Builder International System of Measurements SB

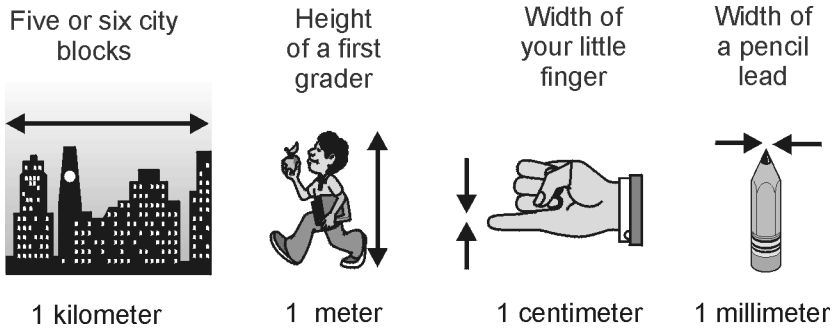
In ancient times, as trade developed between cities and nations, units of measurements were developed to measure the size of purchases and transactions. Greeks and Egyptians based their measurements of length on the human foot. Usually, it was based on the king's foot size. The volume of baskets was measured by how much goatskin they could hold. Was this a reliable method of measurement? Why or why not?

In this skill sheet you will learn about the international system of measurements and how to use the system to make measurements and solve problems.

1. A short history of measurement

During the Renaissance, as scientists began to develop the ideas of physics and chemistry, they needed better units of measurements to communicate scientific data more efficiently. Scientists such as Kepler, Galileo, and Newton needed to prove their ideas with data based on measurements that other scientists could reproduce.

In March 30, 1791, in Sevres, France, the French Academy of Sciences proposed a system that would be simple and consistent. The French Scientists based the units of length on a fraction of the distance between the Earth's equator and the North Pole along a line passing through Paris. The system's basic unit for measuring length was called a *meter* after the Greek word *metron* meaning "measure." The set of equations below will show you how the meter is related to other units in this system of measurements.



1 meter = 100 centimeters

1 cubic centimeter = 1 cm^3 = 1 milliliter

1000 milliliters = 1 liter

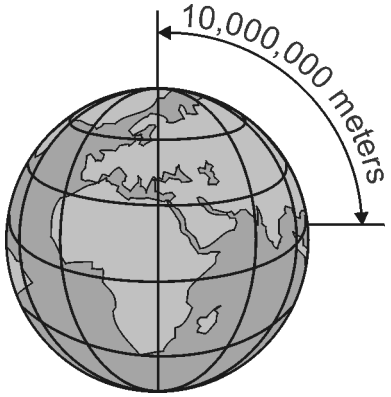
The *liter* was defined as the new standard for volume. One *milliliter* was equal to the volume of one cubic centimeter. The *gram* was defined as the standard for mass. The gram was defined as the mass of one milliliter of water.

2. Today's international system of measurement

Today, the length of a meter is defined as the distance light travels in a small fraction of a second. The *kilogram* is the current "base unit" for mass. A kilogram is defined as the mass of a certain lump of platinum and iridium that is kept in Paris under glass to protect it from chemical changes that could alter its mass. The ***metric system*** is also called the ***SI system***, from the French Le Systemè International d'Unites.

The United States adopted the metric system in 1884. However, the adoption process has been slow, and many Americans still use the English System (feet, inches, and pounds). Since 1992, U.S. government agencies have been required to use the metric system in business transactions.

You may think that only scientists use the metric system, but the majority of people in the world use the metric system of measurements in their daily lives. If you travel overseas, you will find that a car's speed is measured in kilometers per hour. At the gas station, gasoline is sold in liters. Amounts of food are measured in grams. The daily temperature is reported in degrees Celius.



The metric system is easy to use because all the units are based on factors of 10. In the English system, there are 12 inches in a foot, 3 feet in a yard, and 1,760 yards in a mile. In the metric system, there are 10 millimeters in a centimeter, 100 centimeters in a meter, and 1,000 meters in a kilometer. How many kilometers is it from the North Pole to the equator? *Answer: 10,000 kilometers.*

3. Units of measurement in the metric system

These are the base units of measurement that you will use in your scientific studies. The prefixes above are used with the base units when measuring very large or very small quantities.

When you are measuring:	Use this base unit:	Symbol of unit
mass	kilogram	kg
length	meter	m
volume	liter	L
force	newton	N
temperature	degree Celsius	°C
time	second	sec or s

You may wonder why the kilogram, rather than the gram, is called the base unit for mass. This is because the mass of an object is based on how much matter it contains as compared to the standard kilogram made from platinum and iridium and kept in Paris. The gram is such a small amount of matter that if it had been used as a standard, small errors in reproducing that standard would be multiplied into very large errors when large quantities of mass were measured.

4. Metric Prefixes

The following prefixes in the SI system indicate the multiplication factor to be used with the basic unit. For example, the prefix *kilo-* is for a factor of 1,000. A kilometer is equal to 1,000 meters and a kilogram is equal to 1,000 grams.

Prefix	Symbol	Multiplication Factor	
pico–	p	0.000000000001	$= 10^{-12}$
nano–	n	0.000000001	$= 10^{-9}$
micro–	μ	0.000001	$= 10^{-6}$
milli–	m	0.001	$= 10^{-3}$
centi–	c	0.01	$= 10^{-2}$
deci–	d	0.1	$= 10^{-1}$
deka–	da	10	$= 10^{1}$
hecto–	h	100	$= 10^{2}$
kilo–	k	1,000	$= 10^{3}$
mega–	M	1,000,000	$= 10^{6}$
giga–	G	1,000,000,000	$= 10^{9}$
tera–	T	1, 000, 000, 000, 000	$= 10^{12}$

5. Practice using metric prefixes

Use the following sample problems to help you answer the questions below.

Sample problem: *How many centimeters are in a hectometer?*

- Find the multiplication factor in exponent form. In this case the multiplication factor for *centi-* is 10^{-2}. The multiplication factor for *hecto-* is 10^{2}.
- Find the *absolute value* of the difference of the exponents.

$$-2-2=4$$

- The number that you get (in this case, "4") tells you how many zeros to place after the number one (1) to get the correct answer. There are 10^{4}, or 10,000 centimeters in a hectometer.

1. How many milligrams are in one gram?

2. How many centimeters are in a kilometer?

3. How many microliters are in one liter?

4. How many nanoseconds are in one second?

5. How many micrograms are in one kilogram?

6. How many milliliters are in a megaliter?

6. Challenge:

1. A deciliter is how many times larger than a milliliter?

2. A micrometer is how many times smaller than a millimeter?