SI System of Measurement

In the late 1700's, as scientists began to develop the ideas of physics and chemistry, it became clear that an international system of measurements would help them communicate scientific data more effectively. Scientists needed to prove their ideas with data based on measurements that other scientists could reproduce. A decimal system of units based on the meter as a standard length, the kilogram as a standard mass, and the liter as a standard volume was developed by the French. Today this system is known as the metric system, or SI system. The equations below show how the meter is related to other units in this system of measurements.

$$1 \text{ meter} = 100 \text{ centimeters}$$
$$1 \text{ cubic centimeter} = 1 \text{ cm}^3 = 1 \text{ milliliter}$$
$$1000 \text{ milliliters} = 1 \text{ liter}$$

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 5,280 feet 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. From the graphic, how many kilometers is it from the North Pole to the equator?

Answer: You need to convert 10,000,000 meters to kilometers. Since 1 meter = 0.001 kilometers, 0.001 is the multiplication factor. To solve, multiply 10,000,000 × 0.001 km = 10,000 km. So, it is 10,000 kilometers from the North Pole to the equator.
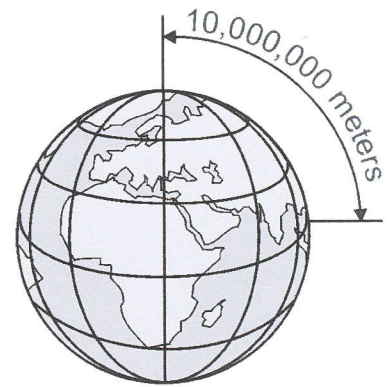
These are the standard units of measurement that you will use in your scientific studies. The prefixes listed on the next page are used with the base units when measuring very large or very small quantities.

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

You may wonder why the kilogram, rather than the gram, is called the standard 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.

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

Prefix	kilo-	hecto-	deca-	Basic unit (no prefix)	deci-	centi-	milli-
Symbol	k	h	da	m, l, g	d	c	m
Multiplication Factor or Place-Value	1,000	100	10	1	0.1	0.01	0.001

EXAMPLE ▶

- **How many centigrams are there in 24 grams?**

  (1) Restate the question: 24 grams = _____ centigrams

  (2) Use the place value chart to determine the multiplication factor, and solve:

kilo	hecto	deca	meter, liter, or gram	deci	centi	milli
thousands	hundreds	tens	ones	tenths	hundredths	thousandths

Since we want to convert grams (ones place) to centigrams (hundredths place), count the number of places on the chart it takes to move from the ones place to get to the hundredths place. Since it takes 2 moves to the right, the multiplication factor is 100.

$24.00 \times 100 = 24.0.0. = 2,400$

move decimal two places to the right

Solution: multiply $24 \times 100 = 2,400$.

Answer: There are 2,400 centigrams in 24 grams.

- **How many liters are there in 5,000 deciliters?**

  (1) Restate the question: 5,000 deciliters (dl) = _____ liters (l)?

  (2) Use the place value chart to determine the multiplication factor, and solve:

Since we want to convert deciliters (tenths place) to liters (ones place), count the number of places on the chart it takes to move from the ones place to get to the hundredths place. Since it takes 1 move to the left, the multiplication factor is 0.1

$5,000 \times 0.1 = 500.0. = 500$

move decimal one place to the left

Solution: multiply $5,000 \times 0.1 = 500$.

Answer: There are 500 liters in 5,000 deciliters.

- **How many decimeters are in a decameter?**

  (1) Restate the question: 1 dam = _____ dm. (Notice decameter is abbreviated dam.)

  (2) Use the place value chart to determine the multiplication factor, and solve:

Since we want to convert decameters to decimeters, count the number of places on the chart it takes to move from the tens place (deka) to the tenths place (deci). It takes 2 moves to the right, so the multiplication factor is 100.

$1.00 \times 100 = 1.0.0. = 1$

move decimal two places to the right

Solution: multiply $1 \times 100 = 100$.

Answer: There are 100 decimeters in one decameter.

- **How many kilograms are equivalent to 520,000 centigrams?**

  (1) Restate the question: 520,000 centigrams = _____ kilograms.

  (2) Determine the multiplication factor, and solve:

  Moving from the hundredths place (centi) to the thousands place (kilo) requires moving 5 places to the left, so the multiplication factor is 0.00001

  $$520,000 \times 0.00001 = 5.2.0.0.0.0. = 5.2$$

  move decimal five places to the left

  Solution: Multiply $520,000 \times 0.00001 = 5.2$.

  ANSWER: 5.2 kilograms are equivalent to 520,000 centigrams.

PRACTICE

1. How many grams are in a decagram?

2. How many millimeters are there in one meter?

3. How many millimeters are in 6 decimeters?

4. Convert 4,200 decigrams to grams.

5. How many liters are equivalent to 500 centiliters?

6. Convert 100 millimeters to meters.

7. How many milligrams are equivalent to 150 decagrams?

8. How many liters are equivalent to 0.3 kiloliters?

9. How many centimeters are in 65 kilometers?

10. Twelve decagrams are equivalent to how many milligrams?

11. Seven hundred twenty centiliters is how many liters?

12. A fountain can hold 53,000 deciliters of water. How many kiloliters is this?

13. What is the name of a length that is 100 times larger than a millimeter?

14. How many times larger than a centigram is a decagram?

15. Name the distance that is 10 times smaller than a centimeter.