

Nature of Science



The
International
System of Units

Why do we need to be able to

To make sense, and

measurements need both . . .

building a house

Unit by itself doesn't make sense

A Number and a Unit!



Idea

Estimation

Estimation is using your knowledge of something similar in size or amount to determine the size of the new object.

- Helps to make a rough measurement of an object.
- Usefully when you are in a hurry and exact numbers are not required.



Precision and Accuracy

Precision is a description of how close measurements are to each other.



Accuracy is comparing your measurement to the actual or accepted value.

Why use the SI System?

In the U.S. we use the English or Standard System, most of the rest of the world uses the Metric or SI System.

- The SI (International System of Units) system is the form of measurement typically used by scientists.
- Measurements are easier to convert than the English system.

International System of Units

SI

le Système International d'unités

Basic Types of Measurement

Length: measures distance between objects

Volume: measures the amount of space something takes up

Mass: measures the amount of matter in an object

Other Types of measurement include:



- ✓ time
- ✓ temperature
- ✓ density
- ✓ PH

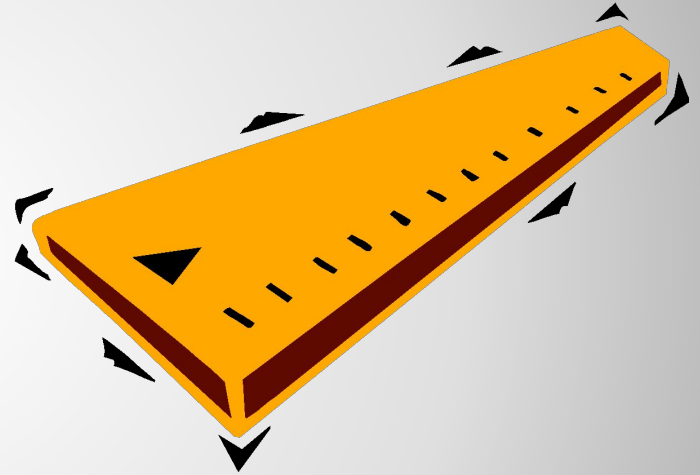
Measurement System Comparisons

MEASUREMENT	ENGLISH	SI SYSTEM
LENGTH	Yard / Inch	Meter
MASS	Ounce / Pound	Kilogram
VOLUME	Quart	m ³
TEMPERATURE	Fahrenheit	Kelvin
TIME	Second	Second

All Measurement systems have standards. Standards are exact quantities that everyone agrees to use as a basis of comparison.

In the English system you have to remember so many numbers . . .

- 12 inches in a foot
- 3 feet in a yard
- 5,280 feet in a mile
- 16 ounces in a pound
- 4 quarts to a gallon



In the SI System you only have to remember one number.

The SI System is based on the number
10.

The SI System uses the following prefixes:

Kilo	1000
Hecto	100
Deca	10
UNIT	1
Deci	1/10
Centi	1/100
Milli	1/1000

This system works with any SI measurement.

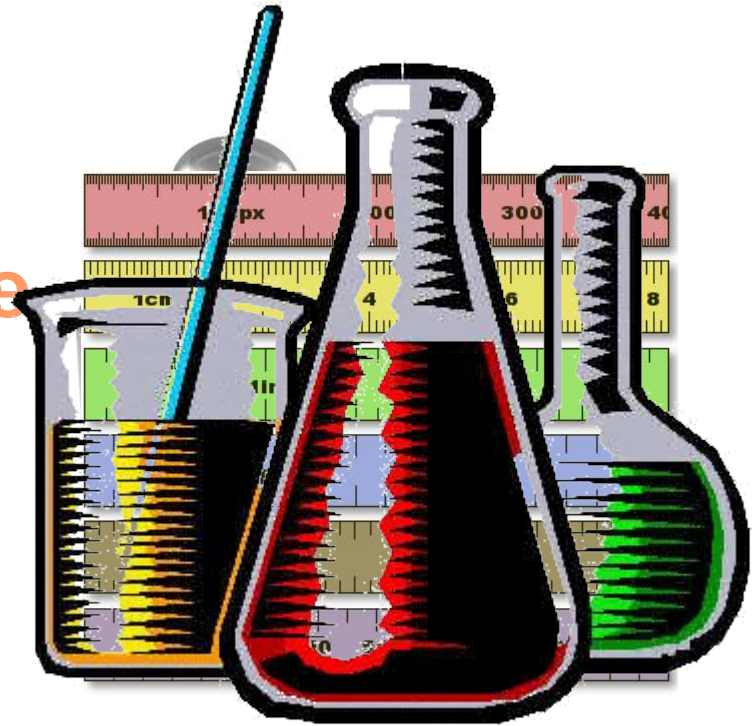
The UNIT becomes whichever type of measurement you are making. (mass, volume, or length)

It is the same system regardless if you are measuring length, mass, or volume.

It works for all types of measurement.

If your measuring . . .

Length then it is the
meter (kilometer,
the liter (deciliter,
deciliter, etc.)
hectoliter, etc.)



centigram

The first part of the term indicates the amount,
the second part indicates the type of
measurement.

How does converting units work?

Unlike the English system converting in the SI System is very easy.

For Example in the English system if you wanted to know how many inches in 2 miles what would you do?

1. Take the number of miles (2).
2. Multiply it by the number of feet in a mile (5,280).
3. Multiply that by the number of inches in a foot (12).

ANSWER: 126,720 inches in 2 miles

The SI system is much easier.

For example in the metric system if you wanted to know how many centimeters were in 3 meters, what would you do?

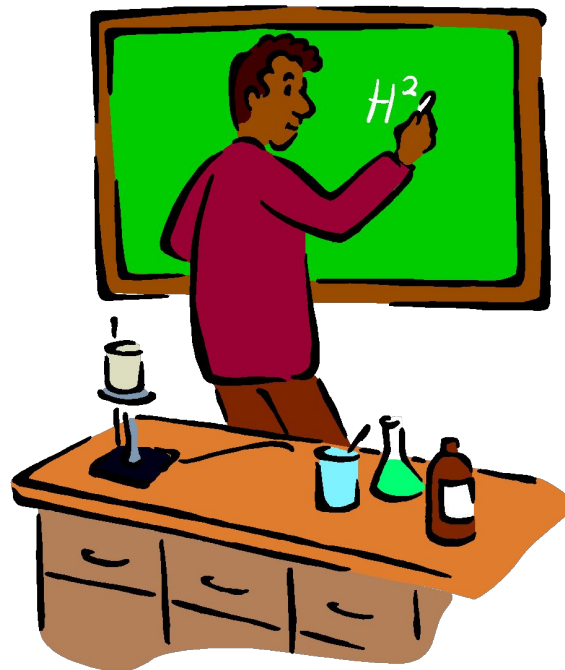
1. Find the unit you have (meters).
2. Find the unit you are changing to (centimeters).
3. Count the number of units in-between (2).
4. Move the decimal point that many spaces, in the same direction you counted (right).

3 meters = 300 centimeters

Kilo Hecto Deca UNIT Deci Centi Milli

Things to Remember

- All measurements need a number and a unit!
- Basic units of Measurement (meter, liter, gram)
- How to convert metric units
- Vocabulary words



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Basic Types of Measurement

Length: measures distance between objects

Volume: measures the amount of space something takes up

Mass: measures the amount of matter in an object

In SI the basic units

are



- ✓ Length is the meter
- ✓ Mass is the gram
- ✓ Volume is the liter (liquid)
- ✓ Temperature is Celsius

Metric Measurement: *Length*

Length is the distance between two points.

- ✓ Does not matter if it is width, height, depth, etc. All are length measurements.
- ✓ The basic unit of length in the SI System is the meter.
- ✓ The meter is about the length of the English yard (3 feet).
- ✓ Area is a variation of a length measurement.
 - Area is length x width.
 - Expressed in units² (m², cm², mm² etc.)

Metric Measurement: *Mass*

Mass is a measurement of the amount of matter in an object.

- ✓ Basic unit of mass is the gram. There are 454 grams in one pound.
- ✓ Weight and mass are related, but NOT the same.
- Weight is the pull of gravity on an object
- The greater the mass, the larger the pull of gravity.

Metric Measurement: *Volume*

Volume is a measurement of the amount of space something takes up.

- ✓ The basic unit used for volume is the liter. This unit is used for the volumes of liquids.
- ✓ Volumes of solids are figured using this formula:

$$\begin{aligned} & \text{(L)ength} \times \text{(W)idth} \times \text{(H)eight} \\ & \text{cm} \times \text{cm} \times \text{cm} = \text{cm}^3 \end{aligned}$$

- ✓ Objects without a definite length, width or height (a rock for example), can use water displacement to determine volume.

NOTE: $1 \text{ ml} = 1 \text{ cm}^3$

Metric Measurement: *Temperature*

Temperature is a measure of the kinetic energy of the atoms in an object.

- ✓ Temperature is measured with a thermometer and measured in Celsius or Kelvin.
- ✓ Celsius ranges from 0 (freezing) to 100 (boiling).
- ✓ The Kelvin scale begins at absolute zero, or 0 K. At 0 Kelvin no more heat can be removed from an object.
 - To convert to Kelvin you add 273 degrees to the Celsius reading.
 - Freezing in Kelvin is 273 K, boiling is 373 K.

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Density is how much matter is in something (mass), compared to the amount of space it takes up (volume).
Which is heavier, a kilogram of feathers or a kilogram of lead?
They are both a kilogram, so they weigh the same, but it takes more feathers than lead to equal one kilogram!

The formula for density is:

Mass (grams) divided by Volume (cm^3)

So the unit for density is g / cm^3

- Every substance has a density, and that density always remains the same.

Which one takes up more space (volume)?
□ Density can be used to figure out what an unknown substance is.
We say the lead is more dense than the feathers.

- The density of water is $1 \text{ g} / \text{cm}^3$

Measurement Review



- **Measurements need a number and a unit!**
- **Basic units of Measurement (meter, liter, gram)**
- **How to convert metric units**
- **Be able to make basic measurements of volume, length, and mass**
- **Definition of density and how to figure it out.**
- **Vocabulary words**