You flip the light switch in your den, but nothing happens. What is wrong?

observation/experiment: Flip light switch, no light.

hypothesis: ~~The bulb is burned out.~~ Breaker tripped?

prediction: ~~Changing the bulb will bring back the light!~~ Reset breaker to bring back the light.

experiment: Change bulb, then try the switch again. Still no light. Reset the correct breaker and re-try switch. Light turns on.

Measurements

Measurements are COMPARISONS of properties against accepted standards, called units.

A properly-reported measurement has TWO PARTS:
(1) a measured NUMBER
(2) a UNIT

English/US Units:

1 foot = 12 in 1 yard = 3ft 1 mile = 1760 ft

5280 ft = 1 mi

So what's the problem?

The English system is hard to learn and use because its units don't relate to one another in any standard way. Different units in the English system use different relationship - meaning lots of memorization.

English units are nonstandard and difficult to use. Solution?

THE METRIC SYSTEM

All metric units are made up of COMBINATIONS of BASE UNITS!

Metric Base Units:

Length	meter	m
Mass	kilogram *	kg
Temperature	Kelvin	K
Time	second	s

* we usually treat the gram as if it's the base unit for mass!

Comparing to the English system:

- One meter is approximately 3.3 feet.
- One kilogram is approximately 2.2 pounds.

What about SIZE?

Metric units may be made larger or smaller by adding PREFIXES.

Metric Prefixes:

mega-	10^{6}	M
kilo-	10^{3}	k
centi-	10^{-2}	c
milli-	10^{-3}	m
micro-	10^{-6}	μ

Bigger units

smaller units

Memorize these prefixes!

Applying prefixes

1 _____ m = _____ m

1 Km = 10^{3} m (1000 m)

1 cm = 10^{-2} m ($\frac{1}{100}$ m)

Scaling units with metric prefixes ... examples

The distance between here and Columbia, SC is about 107,000 meters. What metric unit would be best suited for a distance like this?

k = 10^3 (1000)

107 km

By "best suited", we mean a metric unit that would represent the number without many beginning or end zeros. These kinds of numbers are easier for us to remember!

A piece of chalk is 0.080 meters long. What metric unit would be best suited for this length?

c = 10^{-2} ($\frac{1}{100}$)

8 cm

Derived Units

- are units that are made up of combinations of metric base units with each other and/or with prefixes

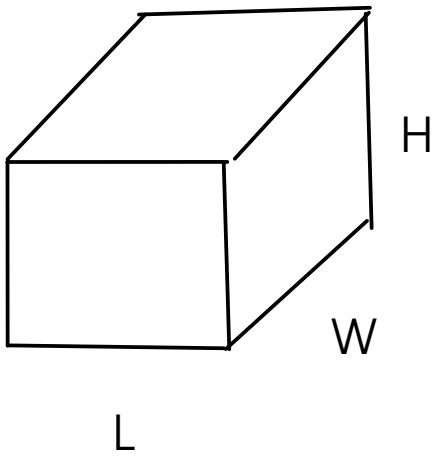
Example: speed $\frac{\text{miles}}{\text{hr}}$, $\frac{\text{km}}{\text{hr}}$ $\left(\frac{\text{length}}{\text{time}}\right)$, $\frac{\text{m}}{\text{s}}$

Two derived units are particularly important in introductory chemistry:

1) VOLUME

2) DENSITY

VOLUME



VOLUME = L × W × H

What are the units of volume in the metric system?

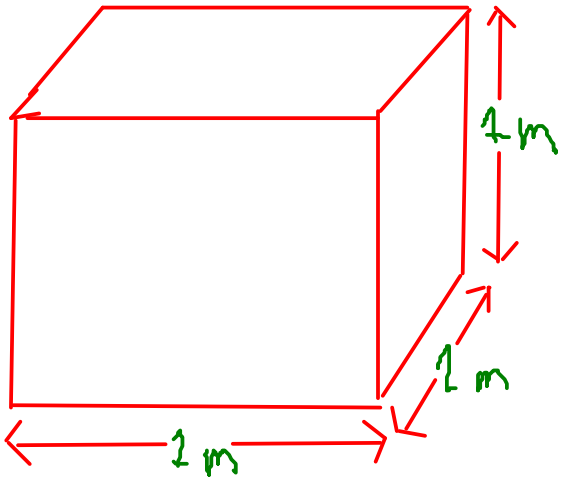
L = LENGTH. = meter (m)

W = WIDTH. = meter (m)

H = HEIGHT. = meter (m)

VOLUME UNIT = meter x meters x meters

= m^3 "cubic meters"



One problem: The cubic meter is TOO LARGE for lab-scale work. We need a smaller unit for CHM 101.

Practical issues for volume units

- Cubic meters are too large! A meter is very similar in length to a yard, so a cubic meter is a cube that is approximately a yard long on each side!

A smaller unit for volume?

Cubic decimeters! dm^3

(decimeter = 1/10 meter)

Cubic decimeters are given the name "liters", abbreviation "L"

In the lab, we typically need an even smaller unit than the liter, so we use milliliters (mL)

"cc"
cubic centimeter
=
milliliter

$1\ mL = 10^{-3} L$

-or-

$1000\ mL = 1\ L$

DENSITY

- Density is a measure of the concentration of matter; of how much matter is present in a given space

- Density is defined as the MASS per unit VOLUME, or ...

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

What are the metric units of DENSITY?

mass : kilogram (kg)

volume : cubic meter (m^3)

So, density unit = $\frac{kg}{m^3}$

This unit has similar problems to the cubic meter, at least for lab work.

1) We don't use cubic meters in the lab (they're too big)

2) We don't use kilograms in the lab, we use grams (typical lab balances have about a 200g maximum)

In the lab, we typically measure masses as grams and volumes as milliliters, so the density unit we will use most often is:

$$\frac{g}{mL}$$

same as $\frac{g}{cm^3}$ or $\frac{g}{cc}$

A useful density to remember:

WATER at room temp: Density = 1 g/mL