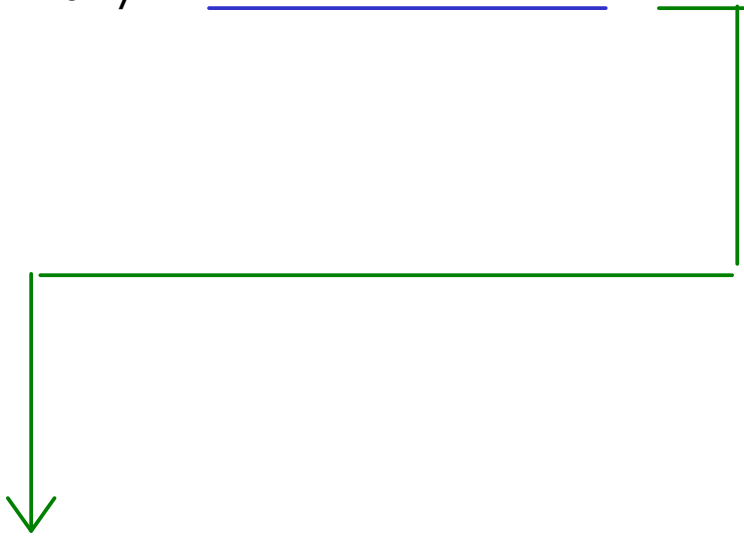
Some basic definitions:

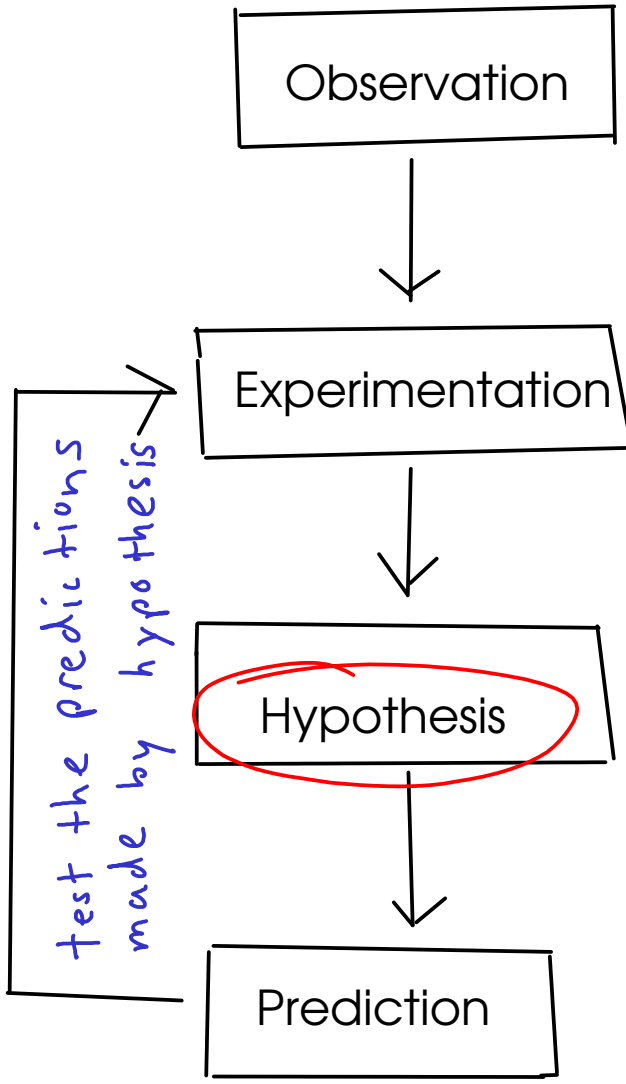
Chemistry: SYSTEMATIC STUDY OF MATTER AND THE CHANGES IT UNDERGOES



Matter: ANYTHING THAT TAKES UP SPACE AND CAN BE PERCEIVED (or DETECTED)

... so what about "SYSTEMATIC STUDY"?

Systematic study? The scientific method



controlled conditions

vary one condition while keeping others the same

initial explanation of observations "WHY?"

Scientific laws

- SUMMARY of observation often in equation form.
- DOES NOT EXPLAIN OBSERVATIONS

Scientific theories

- an EXPLANATION of observations confirmed by repeated experiments
- accepted by most scientists

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

observation/experiment: Flip switch, but no light.

hypothesis: ~~Explanation: The power is off. Did we~~ pay our bill?
Explanation: The bulb is burned out.

prediction: ~~If the bill is paid, we'd have light.~~
Changing the bub will restore the light.

experiment: ~~Check our statement. We find that we DID pay the bill.~~
Change the bulb and the light comes 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 inches 1 yard = 3 feet 1 mile = 1760 yards

5280 ft = 1 mi

So what's the problem? English units are not very consistent. They don't relate to one another in meaningful ways.

This makes the English system both hard to learn AND hard to use. All relationships between units must be memorized independently.

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) $10 \times 10 \times 10 = 10^{3}$

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

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?

$k = 10^3$, so $km = 10^3 m$ (1000m)

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 0.08 meters long. What metric unit would be best suited for this length?

$c = 10^{-2}$, so $cm = 10^{-2} m$ ($1/100 m$)

8 cm

Derived Units

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

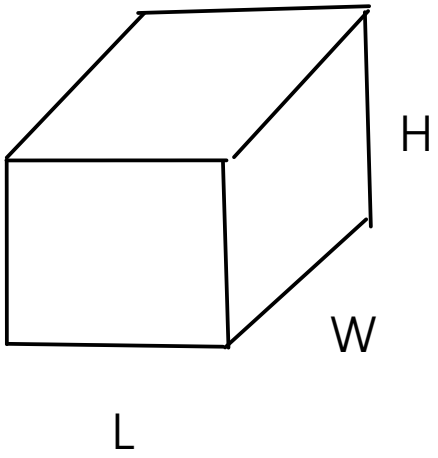
Example: speed $\frac{\text{miles}}{\text{hr}}$, $\frac{\text{Km}}{\text{hr}}$ $\left(\frac{\text{length}}{\text{time}}\right)$, $\frac{\text{m}}{\text{s}}$

Two derived units are particularly important in introductory chemistry:

1) VOLUME

2) DENSITY

VOLUME



VOLUME = L × W × H

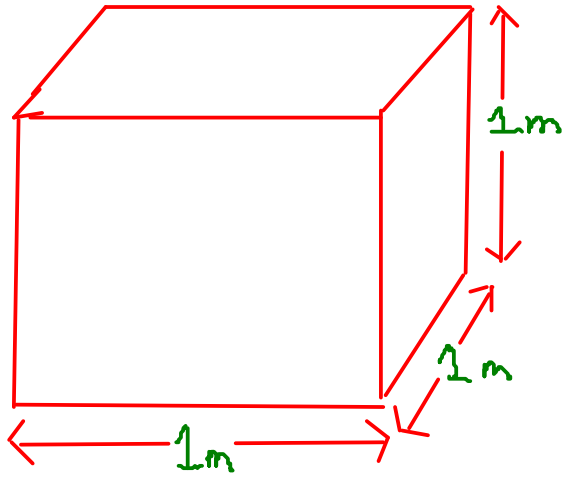
What are the units of volume in the metric system?

L = LENGTH. Base length unit: METER (m)

W = WIDTH. Also a length unit - METER

H = HEIGHT. Also a length unit - METER

VOLUME = (m) × (m) × (m) = m^3 "cubic meters"
L W H



... but the CUBIC METER is too LARGE a unit for lab-scale work. We should use a smaller unit.

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-

$1000\ mL = 1\ L$