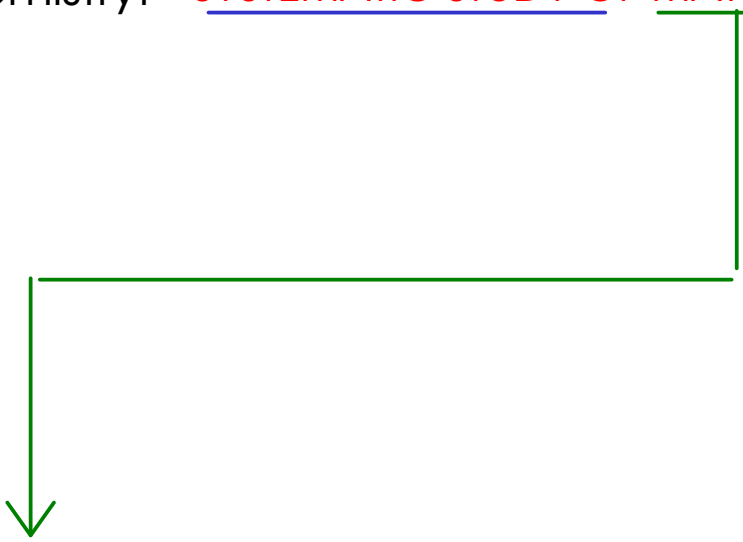
Some basic definitions:

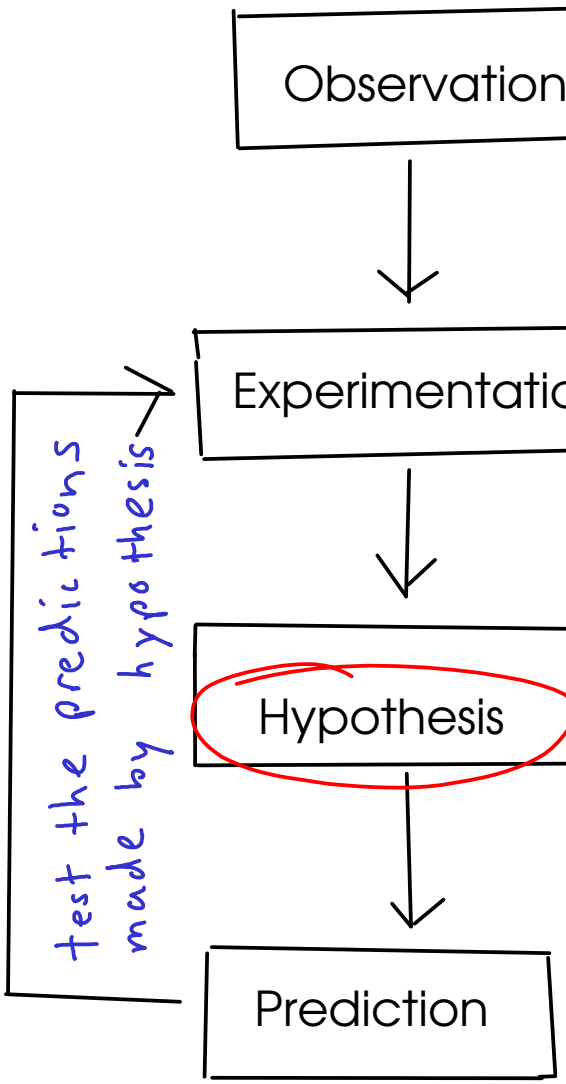
Chemistry: SYSTEMATIC STUDY OF MATTER AND THE CHANGES IT UNDERGOES



Matter: Anything that takes up space and can be perceived (or DETECTED)

... so what about SYSTEMATIC STUDY?

Systematic study? The scientific method



Preferably, under controlled conditions

Vary one (or a limited number of) parameter(s) while keeping others the same

An INITIAL EXPLANATION of observations and experiments

WHY?

Scientific laws

- are SUMMARIES of observations, often in equation form

Scientific laws DO NOT EXPLAIN the observations they are describing. In other words, they tell WHAT, not WHY.

Scientific theories

- are EXPLANATIONS of observations that have been supported by many experiments

- similar to HYPOTHESES, but with a lot more supporting data

Explanations are called theories when there's enough data for most scientists to accept the explanation as valid.

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

observation/experiment: Flip switch, no light.

hypothesis: ~~Bulb is burned out?~~ Circuit breaker tripped?

prediction: ~~If we change the bulb, the light will work.~~ Reset the breaker and we should get light.

experiment: ~~Change the bulb. Still no light.~~ Reset breaker ... 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 = 3 ft 1 mile = 1760 yd

5280 ft = 1 mi

So what's the problem?

1) The conversions between different units for the same kind of measurement (like lengths) don't meaningfully relate to each other.
2) Each kind of unit has a different set of relationships to memorize!

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 (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} (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

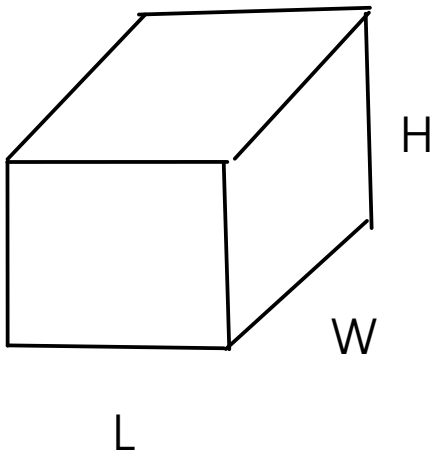
Example: speed $\frac{\text{miles}}{\text{hr}}$, $\frac{\text{km}}{\text{hr}}$ $\left(\frac{\text{length}}{\text{time}}\right)$, $\frac{\text{m}}{\text{s}}$

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?

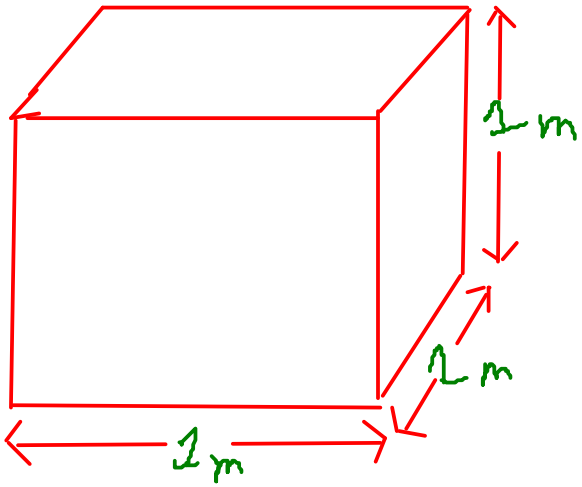
L = LENGTH. = m

W = WIDTH. = m

H = HEIGHT. = m

VOLUME UNIT = m × m × m = m^3

= "cubic meters"



Problem: Cubic meters are much too large a unit for lab-scale or medical work.

So ...

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 : kg (base unit)

volume : m^3 (simplest unit)

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

Problem: We don't usually use cubic meters in lab because they're too big! Also, we don't typically measure mass in the lab in kg because standard lab balances ("analytical balances") can weigh only up to about 200 grams.

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