Mid-Term Topics

Observations

- Qualitative: descriptive observation that is *not numerical*.
  – Example: This apple is red.

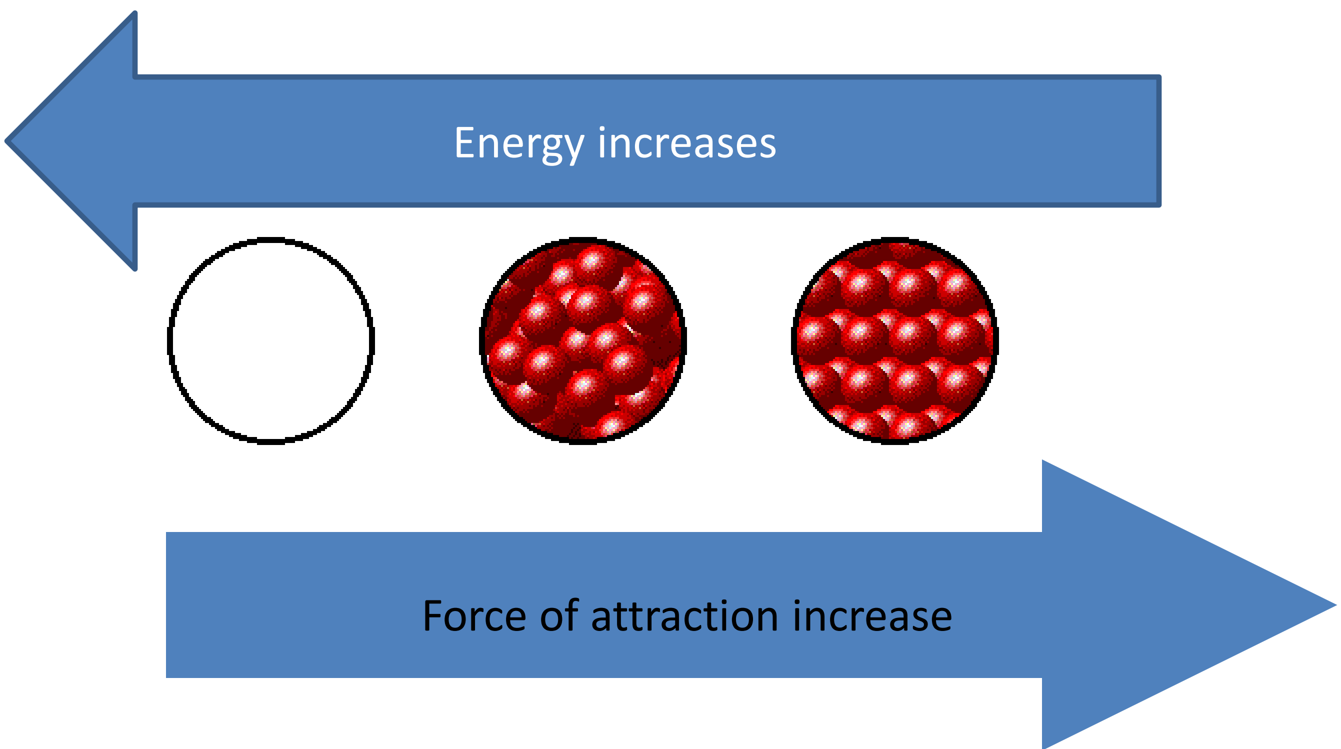
- Quantitative: Numerical observation.
  – Example: The temperature of this room is 23°C.

Laws, Hypotheses, & Theories

- Scientific Laws summarize facts, but do not make any attempt to explain the facts.
  - Example: Law of Conservation of Mass states that *matter can neither be created nor destroyed*.
- A Hypothesis is a tentative, reasonable explanation of the facts or the laws.
- Scientific Theory is a hypothesis that has withstood extensive testing and is known to be true.

States of Matter

- Difference between solids, liquids, & gases are the attractive forces amongst the particles and their energy.

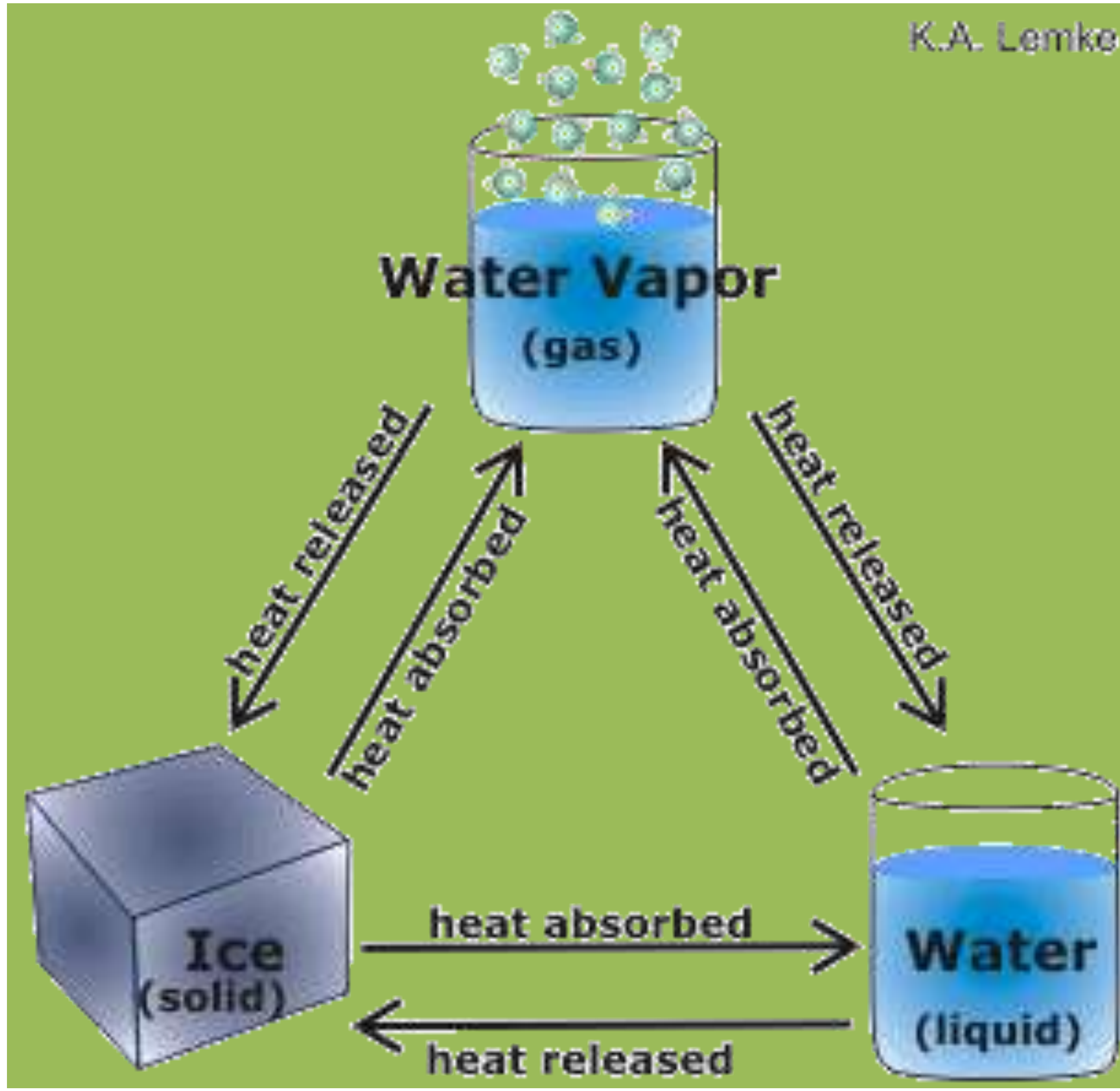


Properties of Solids, Liquids, & Gases

State	Shape	Volume	Compressibility	Microscopic Properties
Solid	Definite	Definite	Negligible	Particles touching & tightly packed in rigid arrays.
Liquid	Indefinite	Definite	Very Little	Particles touching but mobile.
Gas	Indefinite	Indefinite	High	Particles far apart and independent of one another.

Energy and Phase Changes

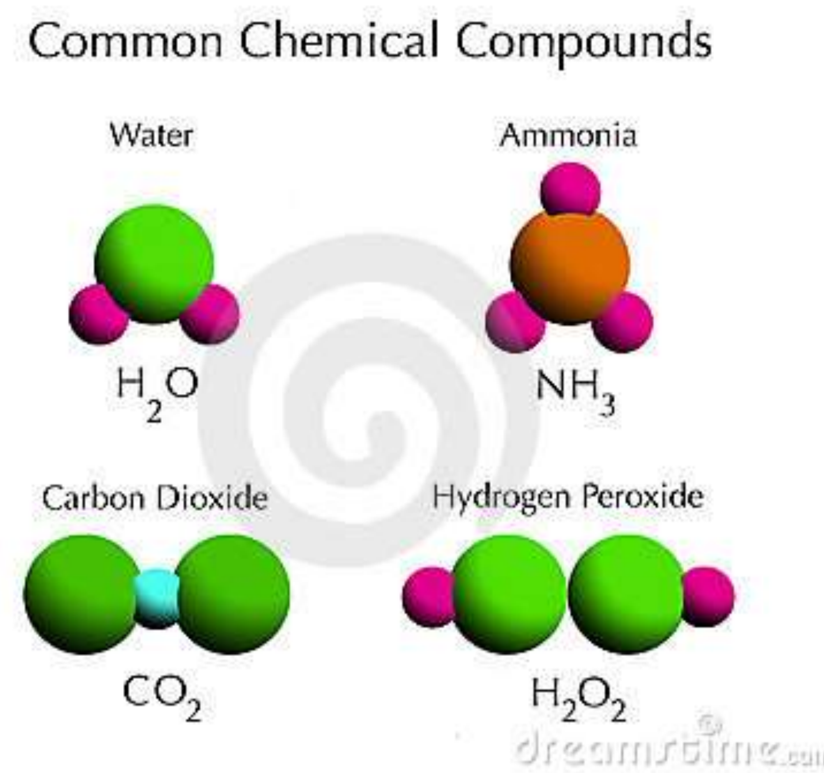
- <u>Endothermic</u> : energy/heat is absorbed
- <u>Exothermic</u> : energy/heat is released



Pure Substances

- Elements and compounds are pure substances.
- Pure substances have a uniform and defined composition.
  - Atoms of Helium always have 2 protons, 2 neutrons and 2 electrons.
  - Sugar, glucose, always has 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms.
- Pure Substances also have distinct properties.

- <u>Compounds</u> are made up of two or more different kinds of elements that are linked together via chemical bonds.



Mixtures

- Two or more substances that are physically combined together.
- Two types of mixtures
  - Homogeneous mixtures have a uniform composition throughout and have the same properties throughout.
  - Heterogeneous mixtures do not have a uniform composition throughout and the properties are not the same throughout.

Physical & Chemical Changes

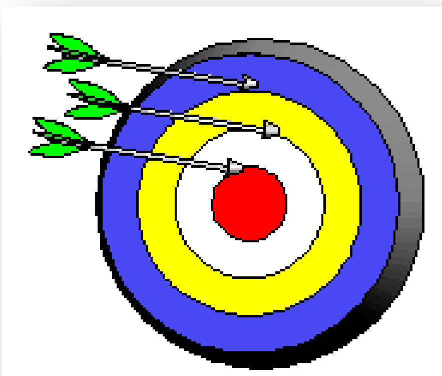
- Physical changes *do not* change to the composition of the substance.
  - Typically involve phase changes.
- In any chemical change, one or more substances are used up while one or more new substances are formed. This means that the composition of the original substance has changed.
  - Chemical reactions are chemical changes.

More on Properties

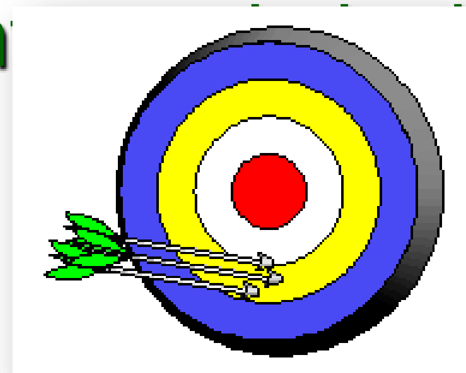
- Intensive Properties *are not* dependent on the amount of matter present.
- Depend on what is **In**side
  - Density, boiling point, color
- Extensive Properties *are* dependent on the amount of matter present.
- Depend on how far they **EX**tend
  - Mass, volume, length

Precision and Accuracy

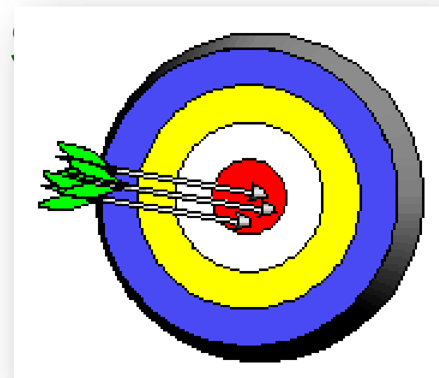
- Accuracy refers to the agreement of a particular value with the true value.
- Precision refers to the degree of agreement among several



Neither accurate nor precise



Precise but not accurate



Precise AND accurate

Why Is there Uncertainty?

- Measurements are performed with instruments
- No instrument can read to an infinite number of decimal places

Which of these balances has the greatest uncertainty in measurement?

- <u>Identifying & Counting Significant Figures:</u>
- Use the *Atlantic-Pacific Rule*! If the decimal point is *absent* approach the number from the *Atlantic* side, go to your first non-zero number, and count all the way through. If the decimal point is *present* approach the number from the *Pacific* side go to your first non-zero number, and count all the way through.

Sig Fig Practice #1

How many significant figures in each of the following?

1.0070 m → 5 sig figs

17.10 kg → 4 sig figs

100,890 L → 5 sig figs

3.29×10^3 s → 3 sig figs

0.0054 cm → 2 sig figs

3,200,000 → 2 sig figs

Rules for Significant Figures in Mathematical Operations

Multiplication and Division: # sig figs in the result equals the number in the least precise measurement used in the calculation.

6.38 x 2.0 =

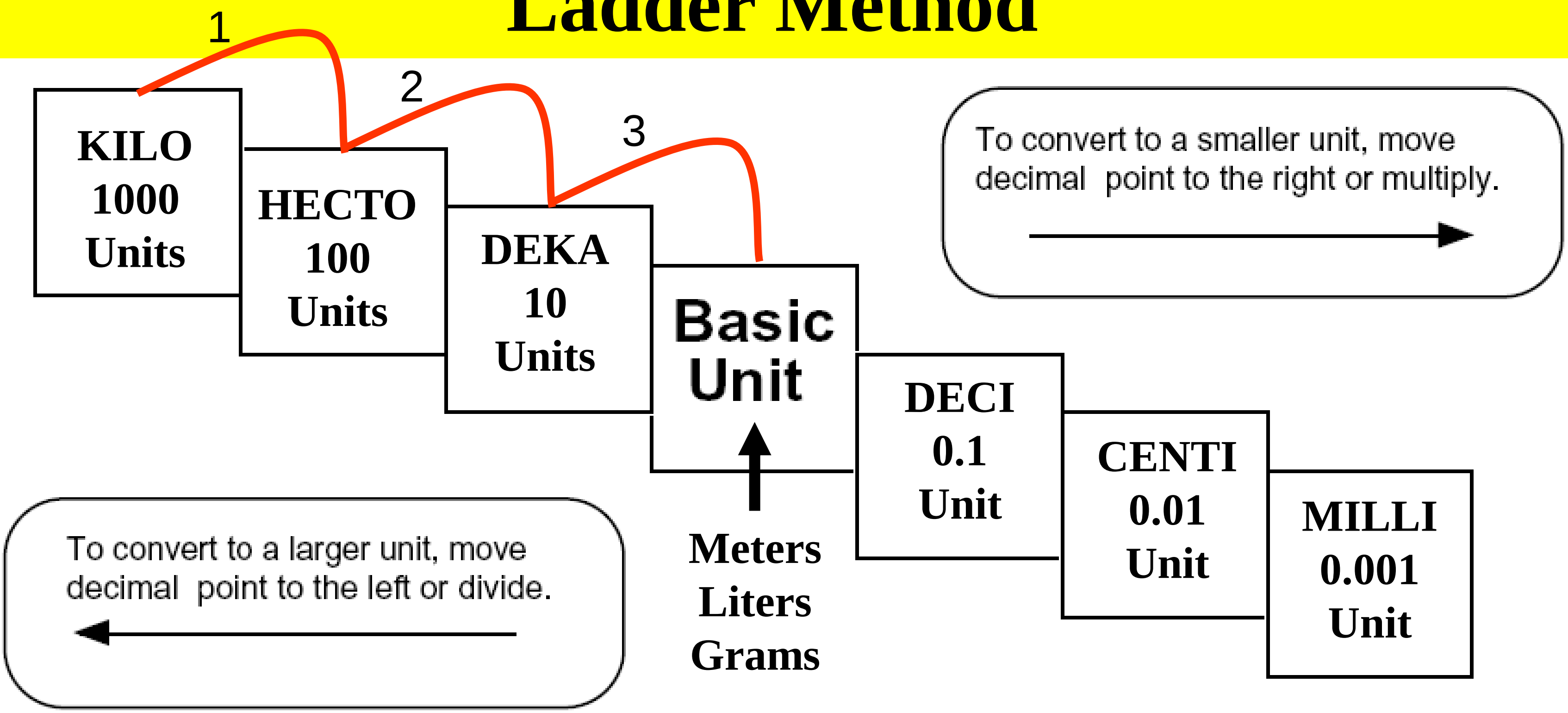
12.76 → 13 (2 sig figs)

Addition and Subtraction: The number of decimal places in the result equals the number of decimal places in the least precise measurement.

6.8 + 11.934 =

18.734 → 18.7 (3 sig figs)

Ladder Method



How do you use the "ladder" method?

1st – Determine your starting point.

2nd – Count the "jumps" to your ending point.

3rd – Move the decimal the same number of jumps in the same direction.

4 km = __________ m

Starting Point   Ending Point

How many jumps does it take?

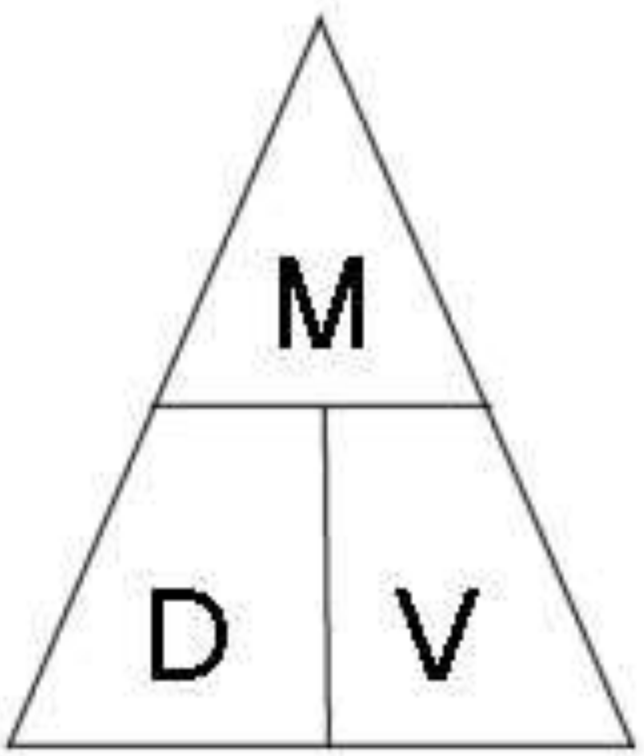
4. __. __. __. = 4000 m

1 2 3

Density- the amount of matter in a unit of volume-

can be used for identification purposes!

Using the density triangle - any variable equation can be found by covering the unknown-



Density Calculations

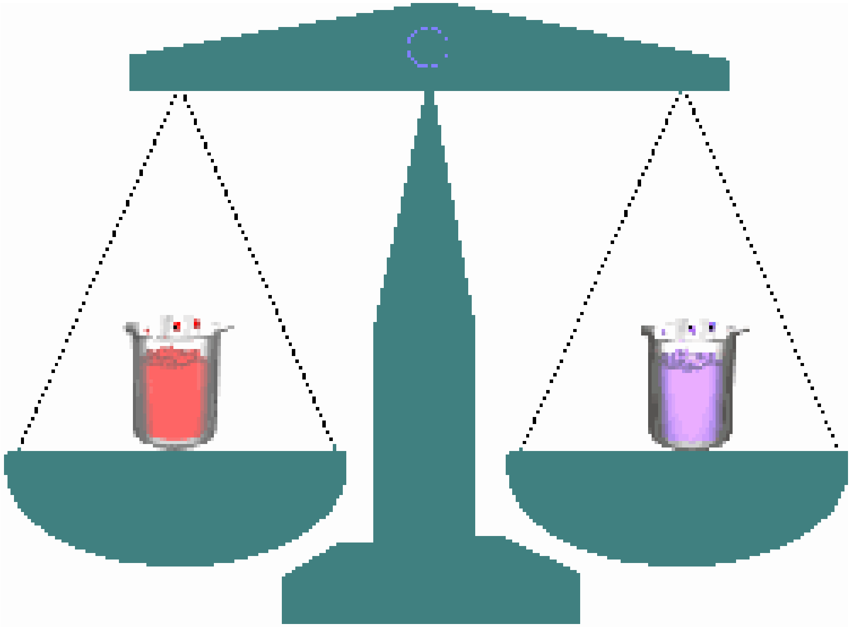
A sample of metal has a mass of 8.4g. The volume of the sample is 3.1cm^3. What is the density?

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{8.4\text{g}}{3.1\text{cm}^3} = 2.7\text{g/cm}^3$$

What is the volume of a sample of liquid Mercury that has a mass of 76.2g. Given that the density of mercury is 13.6g/mL?

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{76.2\text{g}}{13.6\text{g/mL}} = 5.60\text{mL}$$

LAW OF CONSERVATION OF MATTER



Mass is not created (gained) nor destroyed (lost) during ordinary physical and chemical reactions.

Proven by Antoine Lavoisier 200 years ago

LAW OF DEFINITE PROPORTIONS

Chemical compound contains the same elements in exactly the same proportions by mass regardless of sample size or source of substance

1700's Joseph Proust

We all know the chemical formula for water is H_2O . It is essential for the body. The water from a Poland Spring bottle and from a your tap at home is always 2 hydrogen atoms to 1 oxygen atom

LAW OF MULTIPLE PROPORTIONS

Two elements may combine in different ratios to form different compounds.

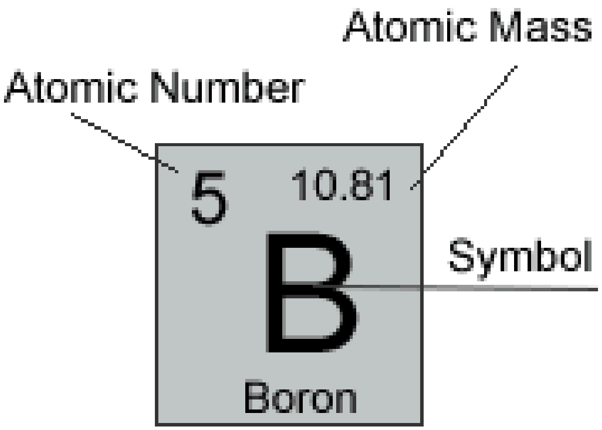
Change the ratio …Change the compound

John Dalton

Water is composed of hydrogen and oxygen in a 2 to 1 ratio needed for body

Hydrogen Peroxide is H_2O_2 in a ratio of 2 to 2. Used as an antiseptic poisonous to body

DETERMINING ATOMIC STRUCTURE



Atomic Number is equal to the number of protons in the nucleus.

Abbreviated as Z

- It is like a social security number because it identifies the element.
- No two elements have the same atomic number.

Element	# of protons	Atomic # (Z)
Carbon	6	6
Phosphorus	15	15
Gold	79	79

MASS NUMBER

Mass number is the number of protons and neutrons in the nucleus of an isotope.

$$Mass\ \# = p^{+} + n^{0}$$

Nuclide	p^{+}	n^{0}	e^{-}	Mass #
Oxygen - 18	8	10	8	18
Arsenic - 75	33	42	33	75
Phosphorus - 31	15	16	15	31

Mass # is abbreviated as *A*

NUCLEAR SYMBOLS

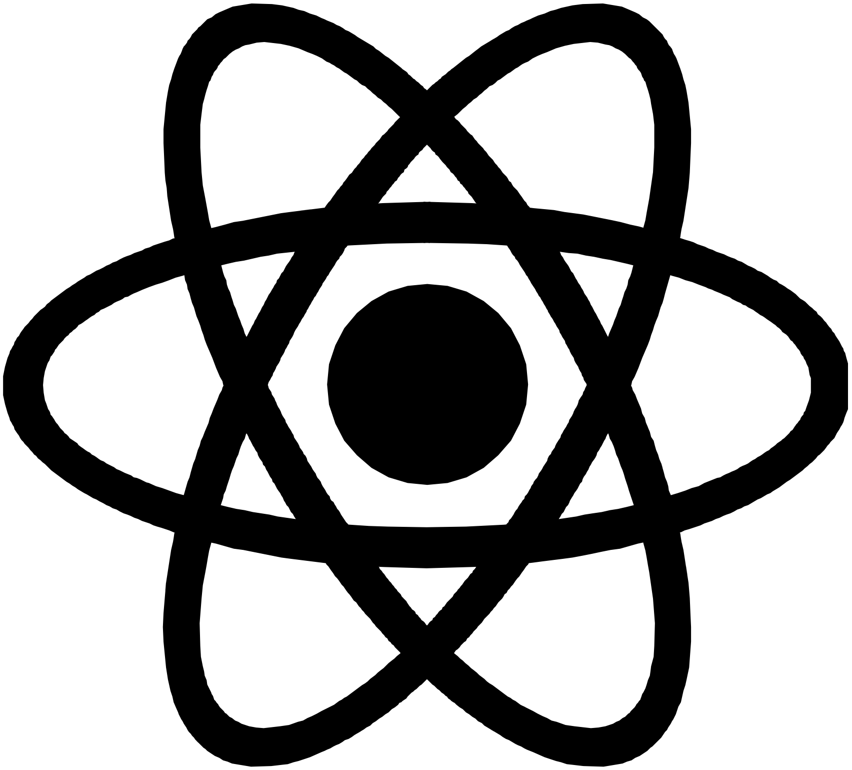
Mass number
(p^{+} + n^{o})

Element symbol

$$^{235}_{92}U$$

Atomic number
(number of p^{+})

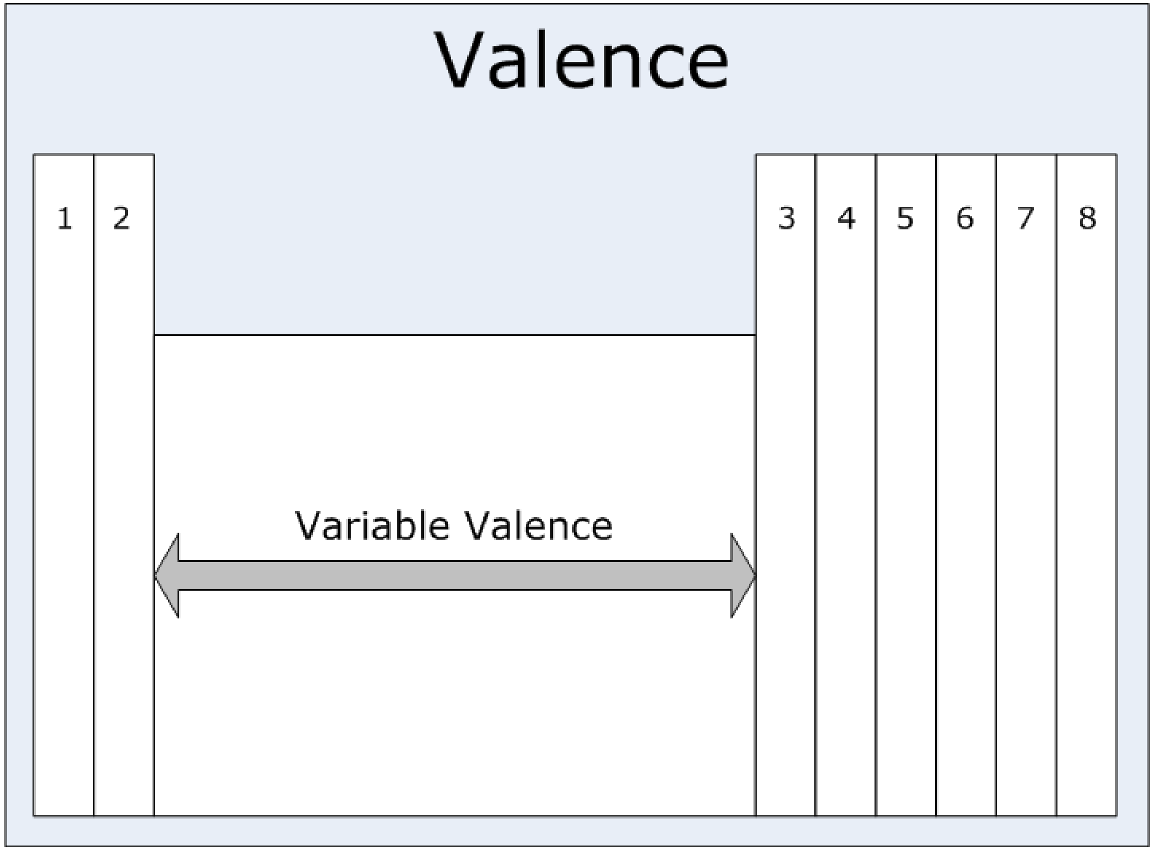
VALENCE ELECTRONS



Valence electrons: an electron that is able to be lost gained or shared during bonding, due to it's location in the outer shell of the electron cloud.

Number of Valence electrons = group number

VALENCE ELECTRONS- OUTERMOST ELECTRONS – RESPONSIBLE FOR REACTIVITY OF THE ATOM

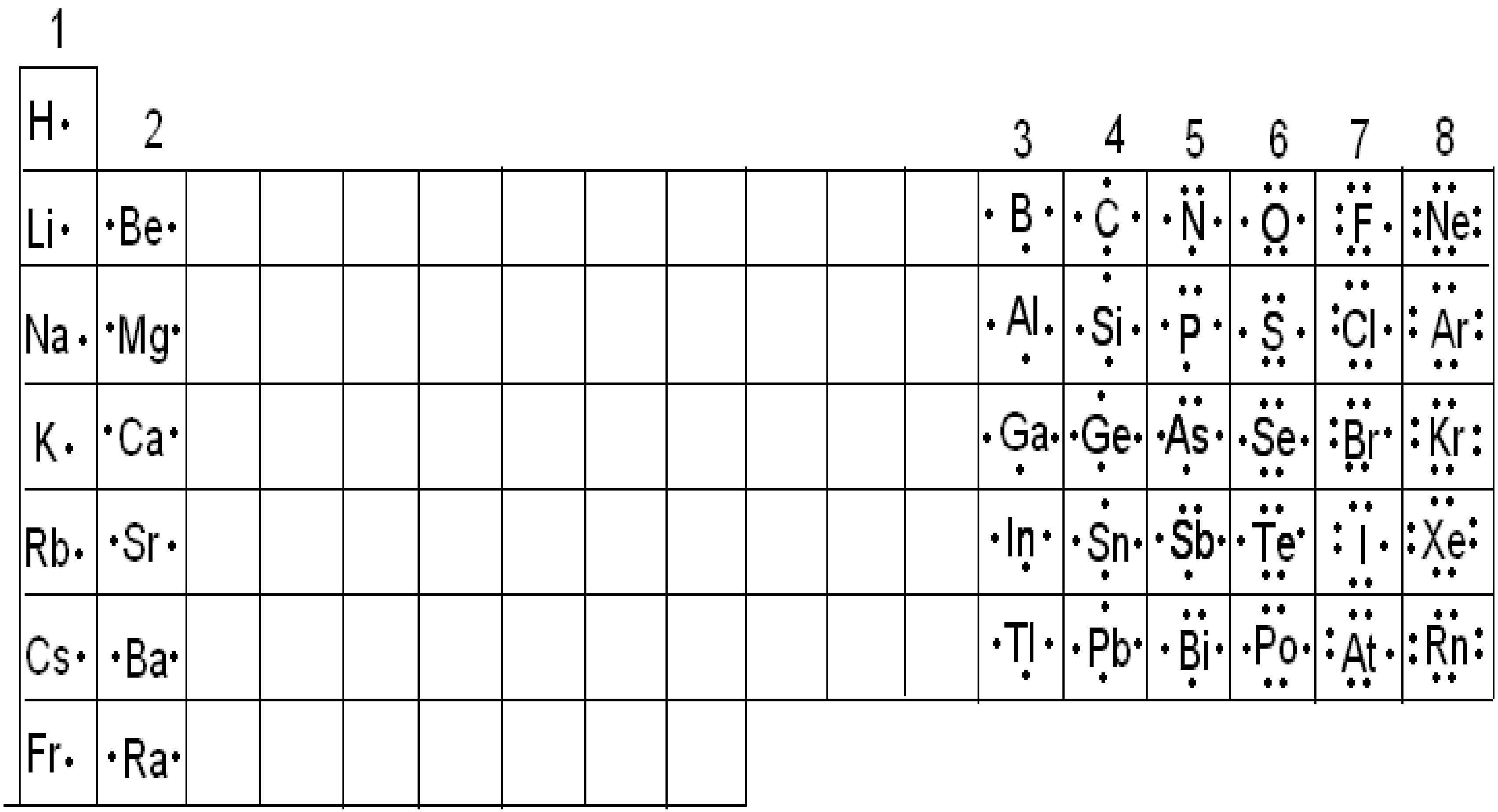


Note: all the elements in the same group have the same number of valence electrons!

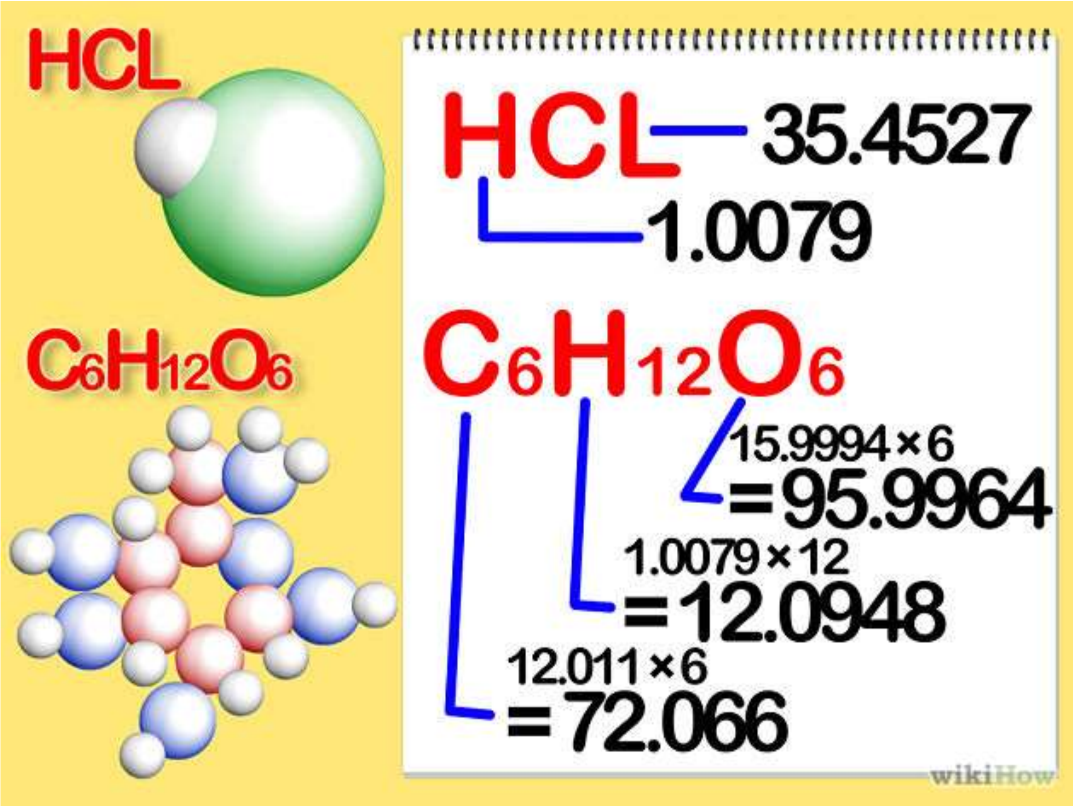
Therefore they are physically and chemically similar!

LEWIS DOT DIAGRAMS

Shows the kernel of the atom (all inner shells and nucleus) as the symbol and dots represent the outer electrons- Valence Electrons



Find the molar mass of each element in the compound. Multiply the element's atomic mass by the molar mass constant by the number of atoms of that element in the compound. Here's how you do it:

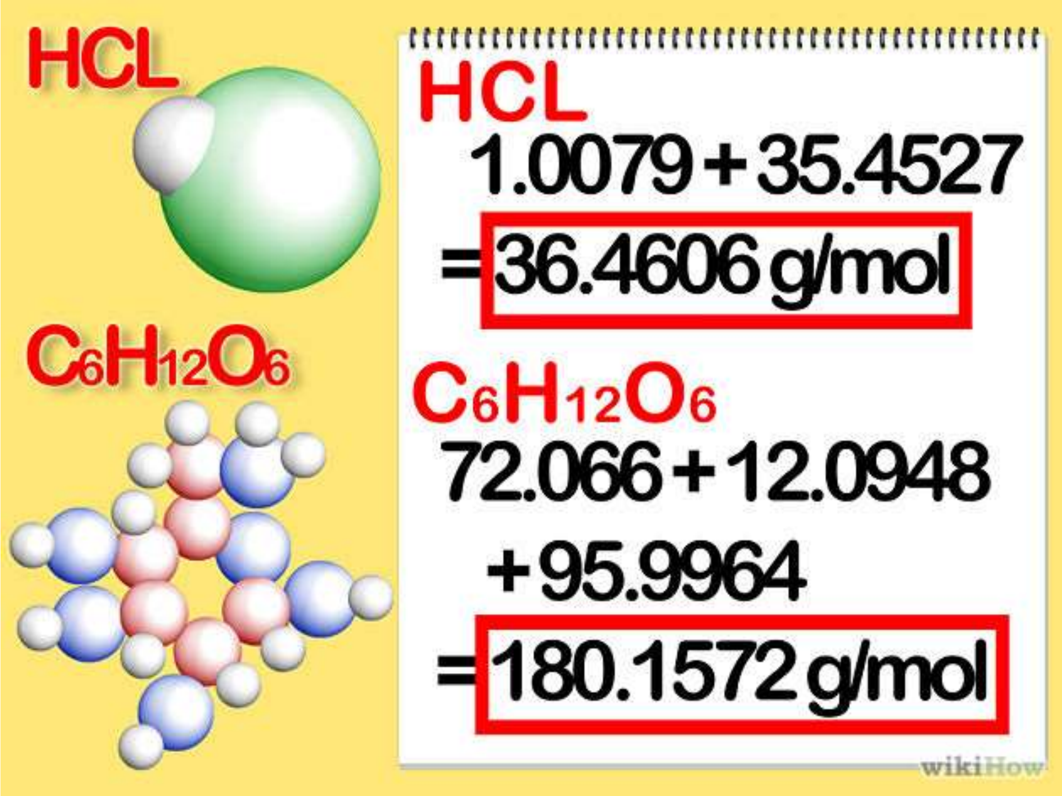


For hydrogen chloride, HCl, the molar mass of each element is 1.007 grams per mole for hydrogen and 35.453 grams per mole for chlorine.

For glucose, $C_6H_{12}O_6$, the molar mass of each element is 12.0107 times 6, or 72.0642 grams per mole for carbon; 1.007 times 12, or 12.084 grams per mole for hydrogen; and 15.9994 times 6, or 95.9964 grams per mole for oxygen.

MOLAR MASS

Add the molar masses of each element in the compound. This determines the molar mass for the compound. Here's how you do it:



For hydrogen chloride, the molar mass is 1.007 + 35.453, or 36.460 grams per mole.

For glucose, the molar mass is 72.0642 + 12.084 + 95.9964, or 180.1446 grams per mole.

CALCULATING PERCENT BY MASS

What is the percent by mass of metal in the compound copper II phosphate? ($Cu_3(PO_4)_2$)

Find total mass

Find mass due to the part

Divide mass of part by total

Multiply by 100

($Cu_3(PO_4)_2$)

subscript → from P.T. →

Cu 3 x 63.55 +

P 2 X 30.97 +

O 8 x 16.00 =

Total mass= 380.59 amu

Mass of metal = 190.7 amu

$$\frac{190.7}{380.59} \times 100 = 50.1\%$$

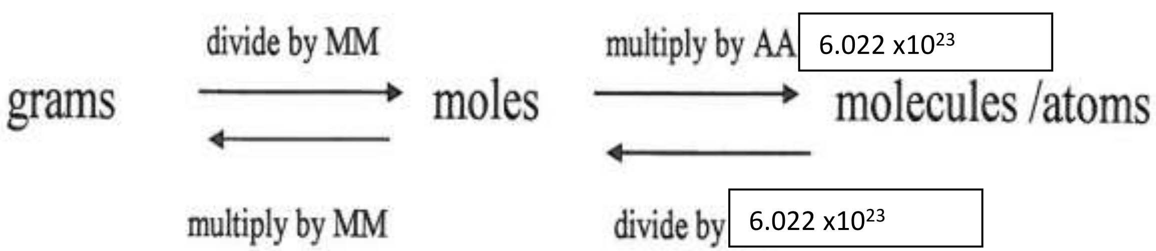
WHAT ARE MOLES??

Chemistry counting unit

Used to count atoms or particles

One mole of any substances contains 6.022×10^{23} atoms or particles

- Particles is somewhat of a generic term that represents a minute piece of matter; like an atom, ion or molecule.



EXAMPLES

How many atoms of Carbon are in 2.25 moles of C?

$$2.25\text{ mol C}\left(\frac{6.022\text{x}10^{23}\text{ atoms C}}{1\text{ mol C}}\right) = 1.35\text{x}10^{24}\text{ atoms C}$$

How many grams are in 3.456 moles of Calcium?

$$3.456\text{ mol Ca}\left(\frac{40.08\text{ g Ca}}{1\text{ mol Ca}}\right) = 138.1648 = 138.2\text{g Ca}$$

How many atoms are in 340g of Magnesium?

$$340\text{ g Mg}\left(\frac{1\text{ mol Mg}}{24.30\text{g Mg}}\right)\left(\frac{6.022\text{x}10^{23}\text{ atoms Mg}}{1\text{ mol Mg}}\right) = 8.4\text{x}10^{24}\text{ atoms Mg}$$

BINARY COMPOUNDS

Binary compounds that contain a metal of fixed oxidation number (group 1, group 2, Al, Zn, Ag, etc.), and a non-metal.

	1+	2+									1+	2+	3+					
1	H 1																	He 2
2	Li 3	Be 4											B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12											Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
5	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
6	Cs 55	Ba 56	*	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
7	Fr 87	Ra 88	Ω	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109									

To name these compounds, give the name of metal followed by the name of the non-metal, with the ending replaced by the suffix –**ide**.

Examples:

NaCl	sodium chloride	(Na^{1+} Cl^{1-})
CaS	calcium sulfide	(Ca^{2+} S^{2-})
AlI_3	aluminum iodide	(Al^{3+} 3 I^{1-})

Criss-Cross Rule

EXAMPLE: ALUMINUM CHLORIDE

Step 1:

write out name with space

Aluminum   Chloride

Step 2:

write symbols & charge of elements

Al^{3+} Cl^{1-}

Step 3:

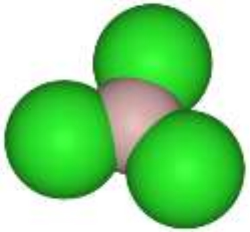
criss-cross charges as subsrcipts

Al_{1} Cl_{3}

Step 4:

combine as formula unit
("1" is never shown)

$AlCl_3$



Type Two **Polyvalent Metals with Elemental Anions**

Pb^{2+}/Pb^{4+},
Sn^{2+}/Sn^{4+},
transition elements (not Ag or Zn)

A. To name, given the formula:

1. Figure out charge on cation.
2. Write name of cation.
3. Write Roman numerals in ( ) to show cation's charge.

Stock System of nomenclature

4. Write name of anion.

FeO	Fe^{2+}	O^{2-}	iron (II) oxide
Fe_2O_3	2 Fe^{3+}	3 O^{2-}	iron (III) oxide
CuBr	Cu^{1+}	Br^{1-}	copper (I) bromide
$CuBr_2$	Cu^{2+}	2 Br^{1-}	copper (II) bromide

NAME THIS COMPOUND! CU_3P_2

1. Find oxidation number of the metal :

$$(3)\ (x) + 2\ (-3) = 0$$

$$X = +2$$

2. state the metal
3. state the value of the Roman Numeral
4. state non-metal change ending to ide

Copper II Phosphide

CHROMIUM (III) CHLORIDE

RECALL: Chromium forms oxides in which metal exhibits oxidation states of +3 and +2. STOCK system indicates oxidation state of compound. Assume Cr^{3+} (chromium (III) chloride).

Step 1: Chromium (III) Chloride

Step 2: Cr^{3+} Cl^{1-}

Step 3: Cr_1 Cl_3

Step 4: $CrCl_3$

Return to Centrum Bottl

TYPE TWO CONT MONOVALENT METALS W/POLYATOMIC IONS

Parentheses are required *only* when you need more than one "bunch" of a particular polyatomic ion.

Ba^{2+}	and	SO_4^{2-}	$BaSO_4$	barium sulfate
Mg^{2+}	and	NO_3^{1-}	$Mg(NO_3)_2$	magnesium nitrate
NH_4^{1+}	and	ClO_3^{1-}	NH_4ClO_3	ammonium chlorate

COMPOUNDS CONTAINING POLYATOMIC IONS

Insert name of ion where it should go in the compound's name.
Cross and Drop Reduce if you can!

Write formulas:

iron (III) nitrate	Fe^{3+}	3 NO_3^{1-}	$Fe(NO_3)_3$
Copper I phosphate	3 Cu^{1+}	$PO_4 3-$	Cu_3PO_4
Silver chlorate	Ag^{1+}	ClO_3^{1-}	$AgClO_3$
Nickel II phosphate	3 Ni^{2+}	2 PO_4^{3-}	$Ni_3(PO_4)_2$
lead (II) permanganate	Pb^{2+}	2 MnO_4^{1-}	$Pb(MnO_4)_2$