LECTURE OUTLINE
Chem111

REVIEW

M E A S U R E M E N T S

I. MEASURED NUMBERS

A. Scientific Notation (exponential notation) - used for expressing very large or very small numbers.

$N \times 10^{ex}$ N = a number from 1 to 9
ex = exponent (the power to which the number 10 is raised)

B. Measured Numbers & Significant Figures

1. Rules for Significant Figures

These are the rules for determining the number of significant figures in a given measured number.

a. Non-zero digits are significant.

b. Zeros between non-zero digits are significant.

c. Zeros to the left of non-zero digits are not significant.

d. Zeros to the right of non-zero digits:

The number of significant figures is ambiguous in a number which has following zeros (zeros to the right of non-zero digits) and no decimal in the number, because these zeros can be either measured numbers (and therefore significant) or place-holders (and therefore not significant). To remove the ambiguity, write the number in scientific notation. It will be assumed that if you write zeros to the right of non-zero digits, whether there is a decimal in the number or not, that you intend for these zeros to be considered to be measured numbers, and therefore significant. (How does your textbook handle this situation?)

(Exact Numbers (counting numbers) have an unlimited number of significant figures.)

2. Rounding Off ANSWERS to the Correct Number of Significant Figures

a. Addition and Subtraction of Measured Numbers
The final answer should be rounded off to the first common place. That is--look at the measured numbers (the numbers to the left of the equal sign) that you are adding or subtracting. Find the measured number that is reported to the fewest number of places after the decimal. The answer should be rounded so that it has no more numbers after the decimal than that number. (Ignore exact numbers when deciding on the number of significant figures in an answer.)

b. Multiplication and Division of Measured Numbers:
The answer should be rounded off to the minimum number of significant figures. That is--look at the measured numbers (the numbers to the left of the equal sign) in the calculation and find the measured number with the smallest number of significant figures. The answer should be rounded to that number of significant figures. (Ignore exact numbers when deciding on the number of significant figures in an answer.)

II. UNITS OF MEASUREMENTS

A. English System vs. Metric System

	METRIC UNITS	ENGLISH UNITS
Mass	basic unit: gram (g)	pound (lb.), ounce (oz.) (These are really units of weight, not mass)
Length	basic unit: meter (m)	foot (ft.), yard (yd.), mile (mi.)
Area	derived units: square meter (m^2) square centimeter (cm^2)	square inch (in^2), square yard (yd^2), square foot (ft^2)
Volume Fluid (liquid or gas) Solid (regular shape)	 basic unit: liter (L) derived units: cubic meter (m^3), cubic centimeter (cm^3) ✶	 gallon (gal), quart (qt.), pint (pt.) cubic inch (in^3), cubic foot (ft^3)

✶ centimeter cubed (cm^3) = cubic centimeter (cc)

REMINDER: $1\ cm^3$ (or cc) = 1 mL

B. Metric System

1. Basic Metric Units: liter (L), meter (m), and gram (g).

2. Metric Prefixes
   The one or two letter abbreviation for a metric prefix is written to the left of the abbreviation for one of the basic units . These prefixes have the following meanings. (The prefixes you are to memorize are given in **boldface** type.)

NEW!

mega- (M)	means	1,000,000	or	1×10^6 times the basic unit
kilo- (k)		1,000		1×10^3
hecto- (h)		100		1×10^2
deka- (da)		10		1×10^1
deci- (d)		0.1		1×10^{-1}
centi- (c)		0.01		1×10^{-2}
milli- (m)		0.001		1×10^{-3}
micro- (μ)		0.000001		1×10^{-6}
nano- (n)		0.000000001		1×10^{-9}
pico- (p)				1×10^{-12}
femto- (f)				1×10^{-15}

III. Other Measurements and Related Calculations to Review

A. Density
B. Specific Gravity
C. Temperature & Conversions: Celsius, Kelvin

CLASSIFICATION OF MATTER

I. PERIODIC TABLE OF THE ELEMENTS

A. Element Symbols and Names - see handout list of element names & symbols to memorize.

B. Reading the Periodic Table

1. Atomic Number
2. Atomic Mass
3. Period vs. Group (family)
4. Metals, Nonmetals and Metalloids
5. Representative Elements
6. Transition Elements (metals)
7. Common Names for Groups IA, IIA, VIIA, VIII

C. DIATOMIC ELEMENTS

hydrogen	fluorine	bromine
nitrogen	chlorine	iodine
oxygen		

D. STATES OF MATTER OF ELEMENTS at room temperature

1. GASES

hydrogen	fluorine	noble gases (group VIII)
nitrogen	chlorine	
oxygen		

2. LIQUIDS

mercury	bromine

3. SOLIDS

all other elements

Matter

A sample of matter is a very large collection of very small particles.

TYPES OF PARTICLES

Atom	Molecule A molecule is a single particle which is com-posed of two or more atoms which are held together by very strong bonds.		Ion An ion is a particle that has a charge. The charge is either positive or negative.	
	Molecule made of like atoms	Molecule made of different atoms	Monatomic Ion An "atom" that has a charge.	Polyatomic Ion A "molecule" that has a charge.
symbol:	formula:	formula:	symbol:	formula:

TYPES OF MATTER

PURE SUBSTANCE A sample of matter (a very large collection of very small particles) in which all the particles are alike.				MIXTURE A sample of matter in which the particles are not all alike	
Element		Compound		Mixture	
Atomic Element Made of Atoms	Molecular Element Made of Molecules (Atoms in the molecules are alike.)	Molecular Compound Made of molecules. (Atoms in the molecules not all alike.)	Ionic Compound Made of Ions. (Formula units)	Homoge-neous Mixture	Heteroge-neous Mixture
symbol:	formula:	formula:	formula:		

N O M E N C L A T U R E

I. NOMENCLATURE OF BINARY COVALENT COMPOUNDS

A. Writing NAMES for Binary Covalent Compounds

1. Write the names of the two elements in the compound
   a. The name of the first element remains the same.
   b. Change the ending of the name of the second element to "ide".

2. Indicate the number of atoms of each element in the compound by using the following Greek prefixes:

mono-	1	hexa-	6	
di-	2	hepta-	7	
tri-	3	octa-	8	MEMORIZE
tetra-	4	nona-	9	
penta-	5	deca-	10	

USE GREEK PREFIXES ONLY WITH COVALENT COMPOUNDS

3. Examples

NO_2

S_4N_4

Br_3Cl_7

B. Writing FORMULAS for Binary Covalent Compounds

sulfur decafluoride

diphosphorus pentabromide

II. NOMENCLATURE OF IONIC COMPOUNDS AND ACIDS

A. Monatomic Ions

1. Nonmetal Ions

SYMBOL	NAME	SYMBOL	NAME
H^+	hydrogen	O^{2-}	oxide
H^-	hydride	S^{2-}	sulfide
F^-	fluoride	N^{3-}	nitride
Cl^-	chloride	P^{3-}	phosphide
Br^-	bromide		
I^-	iodide		

2. Metal Ions

SYMBOL	IUPAC NAME	SYMBOL	IUPAC NAME	COMMON NAME
Li^+	lithium	Cr^{2+}	chromium (II)	chromous
Na^+	sodium	Cr^{3+}	chromium (III)	chromic
K^+	potassium	Mn^{2+}	manganese (II)	manganous
Rb^+	rubidium	Mn^{3+}	manganese (III)	manganic
Cs^+	cesium	Fe^{2+}	iron (II)	ferrous
		Fe^{3+}	iron (III)	ferric
Mg^{2+}	magnesium	Co^{2+}	cobalt (II)	cobaltous
Ca^{2+}	calcium	Co^{3+}	cobalt (III)	cobaltic
Sr^{2+}	strontium	Ni^{2+}	nickel (II)	nickelous
Ba^{2+}	barium	Ni^{3+}	nickel (III)	nickelic
		Cu^+	copper (I)	cuprous
Ag+	silver	Cu^{2+}	copper (II)	cupric
Zn^{2+}	zinc			
Cd^{2+}	cadmium	Sn^{2+}	tin (II)	stannous
Al^{3+}	aluminum	Sn^{4+}	tin (IV)	stannic
		Pb^{2+}	lead (II)	plumbous
As^{3+}	arsenic (III)	Pb^{4+}	lead (IV)	plumbic
As^{5+}	arsenic (V)			
Sb^{3+}	antimony (III)	Au^+	gold (I)	aurous
Sb^{5+}	antimony (V)	Au^{3+}	gold (III)	auric
Bi^{3+}	bismuth (III)	Hg_2^{2+}	mercury (I)	mercurous*
Bi^{5+}	bismuth (V)	Hg^{2+}	mercury (II)	mercuric

*the mercurous ion is actually a polyatomic ion

MONATOMIC IONS

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
H^+																H^-	
Li^+														N^{3-}	O^{2-}	F^-	
Na^+	Mg^{2+}											Al^{3+}		P^{3-}	S^{2-}	Cl^-	
K^+	Ca^{2+}				Cr^{2+} Cr^{3+}	Mn^{2+} Mn^{3+}	Fe^{2+} Fe^{3+}	Co^{2+} Co^{3+}	Ni^{2+} Ni^{3+}	Cu^+ Cu^{2+}	Zn^{2+}			As^{3+} As^{5+}		Br^-	
Rb^+	Sr^{2+}									Ag^+	Cd^{2+}		Sn^{2+} Sn^{4+}	Sb^{3+} Sb^{5+}		I^-	
Cs^+	Ba^{2+}									Au^+ Au^{3+}	Hg_2^{2+} Hg^{2+}		Pb^{2+} Pb^{4+}	Bi^{3+} Bi^{5+}			

C. POLYATOMIC IONS

1. Cations

NH_4^+	ammonium	H_3O^+	hydronium	Hg_2^{2+}	mercury (I) or mercurous

2. Anions

-1		-2		-3	
HSO_3^-	bisulfite	SO_3^{2-}	sulfite		
HSO_4^-	bisulfate	SO_4^{2-}	sulfate		
		$S_2O_3^{2-}$	thiosulfate		
HCO_3^-	bicarbonate	CO_3^{2-}	carbonate		
HS^-	bisulfide			PO_3^{3-}	phosphite
$H_2PO_4^-$	dihydrogen phosphate	HPO_4^{2-}	monohydrogen phosphate	PO_4^{3-}	phosphate
CN^-	cyanide			AsO_4^{3-}	arsenate
SCN^-	thiocyanate	CrO_4^{2-}	chromate	BO_3^{3-}	borate
OCN^-	cyanate	$Cr_2O_7^{2-}$	dichromate		
NO_2^-	nitrite				
NO_3^-	nitrate	$C_2O_4^{2-}$	oxalate		
ClO^-	hypochlorite				
ClO_2^-	chlorite	O_2^{2-}	peroxide		
ClO_3^-	chlorate				
ClO_4^-	perchlorate				
BrO^-	hypobromite				
BrO_2^-	bromite				
BrO_3^-	bromate				
BrO_4^-	perbromate				
IO^-	hypoiodite				
IO_2^-	iodite				
IO_3^-	iodate				
IO_4^-	periodate				
MnO_4^-	permanganate				
OH^-	hydroxide				
$C_2H_3O_2^-$	acetate				

PREFIXES AND SUFFIXES (what they mean)

-ate	"most common variety"	-ide	only one kind of atom in the anion
-ite	one less oxygen atom than "ate" variety (same charge)	thio-	one oxygen atom replaced by S
per-	one more oxygen atom than in "ate" variety (same charge)	bi-	one H^+ added to divalent anion
hypo-	one less oxygen atom than in "ite" variety (same charge)	di-	two

D. Writing FORMULAS for Ionic Compounds & Acids

1. Write the symbol (or formula) for each ion, writing the cation first and the anion last.
2. Place parentheses around formulas for polyatomic ions.
3. Choose subscripts for the ions such that the overall charge is zero. (Remember - a polyatomic ion is a single particle (a molecule that has a charge).
4. Be sure the subscripts are in lowest common denominator form.
5. Rewrite the formula without showing the charges.
6. If the subscript for a monatomic ion is 1, the 1 is not shown.
7. If the subscript for a polyatomic ion is 1, the 1 is not shown and the parentheses are removed.

Examples:

calcium sulfide

ferric oxide

magnesium acetate

cupric nitrite

barium phosphate

ammonium iodide

stannic perchlorate

nickel (II) hydroxide

E. Writing NAMES for Ionic Compounds

Examples:

$CdCl_2$

$Na_2S_2O_3$

$HgBr_2$

Au_2O_3

PbS_2

$KMnO_4$

$Zn(HS)_2$

$Sn(CrO_4)_2$

$Cr(ClO_4)_2$

$Fe(OH)_3$

F. NOMENCLATURE OF ACIDS

Acids are molecular compounds that contain hydrogen.
When these compounds dissolve in water they have acid properties.

1. Naming binary acids

	Regular Names	Aqueous Acid Names
HCl	_____	_____
H_2S	_____	_____

2. Naming Ternary Oxy-Acids

	Regular Names	Aqueous Acid Names
H_2SO_3	_____	_____
HBrO	_____	_____
HNO_3	_____	_____
H_3PO_4	_____	_____
$HClO_4$	_____	_____

3. Writing formulas for acids from aqueous acid names:

AQUEOUS ACID NAME	→	REGULAR NAME	→	FORMULA
hydro_____ic acid	→	hydrogen _____ide		_____
_____ous acid	→	hydrogen _____ite		_____
_____ic acid	→	hydrogen _____ate		_____

Examples: Write formulas for the following:

chlorous acid _____ _____

carbonic acid _____ _____

hydrobromic acid _____ _____

sulfurous acid _____ _____

periodic acid _____ _____

hypoiodous acid _____ _____

hydrocyanic acid _____ _____

dichromic acid _____ _____

CHEMICAL REACTIONS

I. TYPES OF CHEMICAL REACTIONS

A. DECOMPOSITON REACTIONS

In a decomposition reaction a single compound breaks down into two or more products.

1. Decomposition of Binary Compounds

$2\ HgO \longrightarrow 2\ Hg + O_2$

$2\ NaCl \longrightarrow 2\ Na + Cl_2$

2. Decomposition of Ternary Compounds

$BaCO_3 \longrightarrow BaO + CO_2$

$Na_2SO_3 \longrightarrow Na_2O + SO_2$

$2\ NaOH \longrightarrow Na_2O + H_2O$

$2\ NaNO_3 \longrightarrow 2\ NaNO_2 + O_2$

$2\ H_2O_2 \longrightarrow 2\ H_2O + O_2$

➔ Rules for decomposition of ternary compounds (contain polyatomic ion).

a. Carbonates (compounds containing CO_3^{2-}) decompose to oxides and $CO_2(g)$.
   metal carbonate ⟶
   hydrogen carbonate ⟶

b. Sulfites (compounds containing SO_3^{2-}) decompose to oxides and $SO_2(g)$.
   metal sulfite ⟶
   hydrogen sulfite ⟶

c. Chlorates (compounds containing ClO_3^-)decompose to chlorides and $O_2(g)$.
   metal chlorate ⟶
   hydrogen chlorate ⟶

d. Nitrates (compounds containing NO_3^-) decompose to nitrites and $O_2(g)$.
   metal nitrate ⟶
   hydrogen nitrate ⟶

e. Peroxides (compounds containing O_2^{2-}) decompose to oxides and $O_2(g)$.
   metal peroxide ⟶
   hydrogen peroxide ⟶

f. Hydroxides decompose to oxides and water.
   metal hydroxides ⟶

B. COMBINATION REACTIONS

In a combination reaction, two or more substances, elements and/or compounds, combine to form a single product.

$2\ Mg + O_2 \longrightarrow 2\ MgO$

$S + O_2 \longrightarrow SO_2$

$K_2O + SO_2 \longrightarrow K_2SO_3$

$CaO + CO_2 \longrightarrow CaCO_3$

$Na_2O + H_2O \longrightarrow 2\ NaOH$ (metal oxide + $H_2O \longrightarrow$ metal hydroxide)

$SO_2 + H_2O \longrightarrow H_2SO_3$

$CO_2 + H_2O \longrightarrow H_2CO_3$

(nonmetal oxide + $H_2O \longrightarrow$ acid)

$2\ KCl + 3\ O_2 \longrightarrow 2\ KClO_3$ (metal chloride + $O_2 \longrightarrow$ metal chlorate)

$NaNO_2 + O_2 \longrightarrow 2\ NaNO_3$ (metal nitrite + $O_2 \longrightarrow$ metal nitrate)

$2\ BaO + O_2 \longrightarrow 2\ BaO_2$ (metal oxide + $O_2 \longrightarrow$ metal peroxide)

C. SINGLE REPLACEMENT REACTIONS

In a replacement reaction an element reacts with a compound. The element displaces an element from the compound and takes its place.

1. Metals replace metals AND hydrogen

$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$

$Zn + 2\,HCl \longrightarrow ZnCl_2 + H_2$

$2\,Na + 2\,H_2O \longrightarrow 2\,NaOH + H_2$

Activity Series for Common Metals

Most Active

React with acids to form $H_2(g)$:

- K
- Na — React with $H_2O_{(l)}$
- Ca — React with $H_2O_{(l)}$
- Mg — React with $H_2O_{(g)}$
- Al — React with $H_2O_{(g)}$
- Mn — React with $H_2O_{(g)}$
- Zn — React with $H_2O_{(g)}$
- Cr — React with $H_2O_{(g)}$
- Fe
- Ni
- Sn
- Pb

H_2

Do not react with acids to produce H_2 gas*:

- Cu
- Hg
- Ag
- Pt
- Au

Least Active

*These metals may react with acids, but when they do H_2 gas is not produced.

2. Nonmetals replace nonmetals

$Cl_2 + 2\,NaBr \longrightarrow Br_2 + 2\,NaCl$

$Br_2 + 2\,KI \longrightarrow 2\,KBr + I_2$

Activity Series for Halogens:

F_2
Cl_2
Br_2
I_2

D. DOUBLE REPLACEMENT REACTIONS (ion exchange or metathesis)

In a double replacement reaction two compounds react to form two compounds. In the reaction the two compounds "switch last names".

$AgNO_3 + KCl \longrightarrow KNO_3 + AgCl$

$MgS + 2\ HCl \longrightarrow MgCl_2 + H_2S$

$H_2SO_4 + 2\ NaOH \longrightarrow Na_2SO_4 + 2\ H_2O$

$FeCl_3 + 3\ KOH \longrightarrow Fe(OH)_3 + 3\ KCl$

$2\ HNO_3 + K_2CO_3 \longrightarrow 2\ KNO_3 + H_2CO_3$

$KCl + NaOH \longrightarrow KOH + NaCl$

A double replacement reaction will go to completion if:

1. An insoluble solid (precipitate) is produced.

2. A less ionized substance is produced.

3. A gas is produced.

E. COMBUSTION REACTIONS

In a combustion reaction an organic compound reacts with oxygen to produce CO_2 and water.

$CH_4 + 2\ O_2 \longrightarrow CO_2 + 2\ H_2O$

$2\ C_6H_6 + 15\ O_2 \longrightarrow 12\ CO_2 + 6\ H_2O$

$C_2H_6O + 3\ O_2 \longrightarrow 2\ CO_2 + 3\ H_2O$

II. DETERMINING REACTION TYPE & PREDICTING PRODUCTS

REACTANT(S)				RXN TYPE	PRODUCT(S)
ONE COMPOUND	BINARY COMPOUND			DECOMPOSITION	
	TERNARY COMPOUND	CARBONATES	H_2CO_3		
			metal carbonate		
		SULFITES	H_2SO_3		
			metal sulfite		
		CHLORATES	**$HClO_3$**		
			metal chlorate		
		NITRATES	**HNO_3**		
			metal nitrate		
		PEROXIDES	**H_2O_2**		
			metal peroxide		
		HYDROXIDES	**metal hydroxide**		
TWO ELEMENTS	METAL + NONMETAL			COMBI-NATION	
	NONMETAL + NONMETAL				
ELEMENT & COMPOUND	NONMETAL ELEMENT + SALT CONTAINING ANION OF DIFFERENT NONMETAL			SINGLE REPLACE-MENT	
	METAL ELEMENT + SALT CONTAINING CATION OF DIFFERENT METAL (OR ACID OR WATER)				
	METAL CHLORIDE + O_2			COMBI-NATION	
	METAL NITRITE + O_2				
	METAL OXIDE + O_2				
	ORGANIC COMPOUND + O_2			COMBUST-ION	
TWO COMPOUNDS	Both compounds from these classes only: SALT, ACID, METAL HYDROXIDE			DOUBLE REPLACE-MENT	
	TWO OXIDES	METAL OXIDE + H_2O		COMBINATION	
		NONMETAL OXIDE + H_2O	$CO_2 + H_2O$		
			$SO_2 + H_2O$		
		METAL OXIDE + CO_2			
		METAL OXIDE + SO_2			

III. BALANCING EQUATIONS

IV. SYMBOLS USED IN CHEMICAL EQUATIONS

V. WRITING STATES OF MATTER OF ELEMENTS AND COMPOUNDS IN CHEMICAL REACTIONS

A. ELEMENTS

1. No water present: Write state of matter for element as you memorized it at beginning of semester.

2. Water present: Assume elements are not soluble in water, therefore their states are the states of matter at room temperature that you memorized at the beginning of the semester.

B. IONIC COMPOUNDS (salts, metal hydroxides, metal oxides)

1. No Water Present: State of matter is (s).

2. Water Present

   a. SALTS: For a soluble salt, the state of matter is (aq). For an insoluble salt, the state is (s).

   b. METAL HYDROXIDES: For a soluble metal hydroxide, the state of matter is (aq). For an insoluble metal hydroxide, the state is (s).

   c. METAL OXIDES: Assume that the metal oxide would react with the water rather than simply dissolve in it. Therefore, will have no metal oxides that have (aq) as their state.

C. MOLECULAR COMPOUNDS (acids, nitrogenous bases, covalent)

1. No Water Present: For the following molecular compounds only, you must memorize the state of matter at room temperature. These are: $CO_{2(g)}$, $H_2S_{(g)}$, $SO_{2(g)}$, $NH_{3(g)}$, $H_2O_{(l)}$. (If water is produced in a combustion reaction, it is a gas and should be labeled (g).) For any other molecular compound you will be given its state of matter.

2. Water present: In general, polar molecular compounds are soluble in water and nonpolar molecular compounds are insoluble in water.

   a. ACIDS: Assume that all acids are polar and that any acid that is a reactant in chemical reaction is dissolved in water and therefore its state is (aq). For any acid that is a product in a chemical reaction, the state is (aq) since all acids are polar, and therefore are soluble in water. One exception is H_2S, which is very slightly soluble in water, therefore its state is (g).

   b. NITROGENOUS BASES (NH_3): Ammonia is polar and therefore soluble in water, so its state is (aq).

   c. COVALENT: A covalent compound that is polar is soluble in water, therefore the state is (aq). Since you do not yet know how to predict whether a covalent compound is polar or nonpolar, you will be told either that the compound is soluble/insoluble in water or that it is polar/nonpolar. If the compound is insoluble in water, you will write the state of the pure substance, which will be given, unless it is one of the compounds listed in item1, above, whose states you must memorize.

*WATER PRESENT – Water is present if:

1. Water is one of the reactants or products of the reaction.
2. One or both of the reactants of the reaction are dissolved in water.

Otherwise, water is not present.

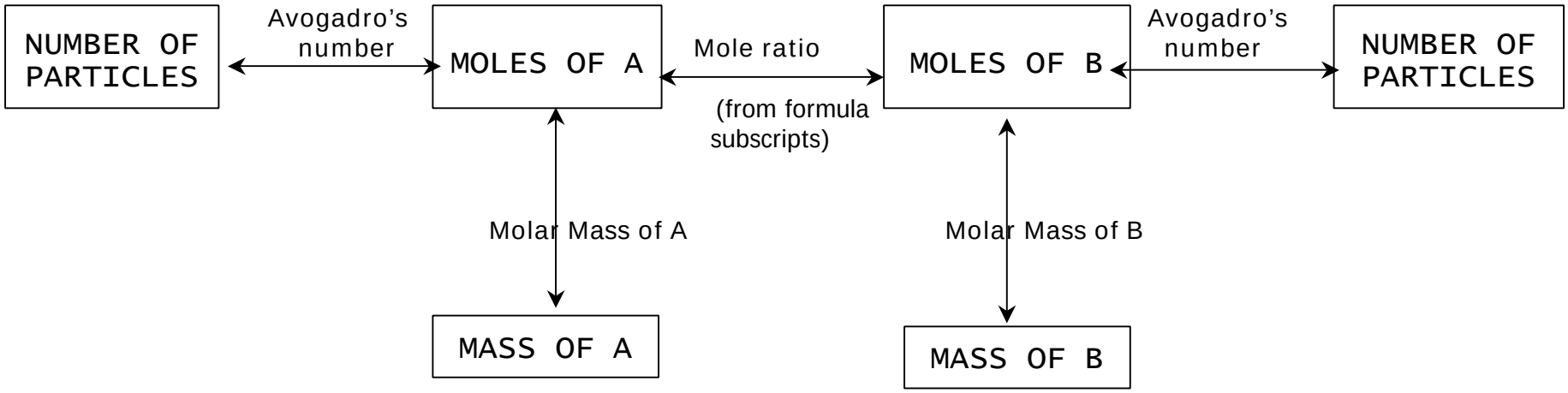
SOLUBILITY RULES FOR IONIC COMPOUNDS

SOLUBLE IN WATER		
SOLUBLE IF IT CONTAINS THIS ION		WITH THESE exceptions
CATION	ANION	
group IA		
NH_4^+		
	NO_3^-	
	$C_2H_3O_2^-$	
	Cl^-, Br^-, I^-	Ag^+, Pb^{2+}, Hg_2^{2+}
	SO_4^{2-}	Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
INSOLUBLE IN WATER		
INSOLUBLE IF IT CONTAINS THIS ION		WITH THESE exceptions
CATION	ANION	
	CO_3^{2-}, CrO_4^{2-}, PO_4^{3-}	group IA, NH_4^+
	S^{2-}	group IA, group IIA, NH_4^+
	OH^-	group IA, Ca^{2+}, Sr^{2+}, Ba^{2+}

STRONG ACIDS AND BASES

STRONG BASES (SOLUBLE METAL HYDROXIDES)		STRONG ACIDS	
LiOH	$Sr(OH)_2$	HCl	HNO_3
NaOH	$Ba(OH)_2$	HBr	$HClO_4$
KOH	$Ca(OH)_2$	HI	H_2SO_4
RbOH			
CsOH			

CHEMICAL FORMULA CALCULATIONS



PARTICLES = ATOMS, IONS, MOLECULES, OR FORMULA UNITS

A. SIMPLE CHEMICAL FORMULA CALCULATIONS

1. How many moles of each element are in 8.56 moles of $Al_2(SO_4)_3$?

2. How many grams of oxygen are in 12.5 g CO_2 (molar mass = 44.0)?

3. If you had 1.25×10^{27} water molecules , how many moles of water would you have?

4. How many formula units are in 12.869 g of $Ca(ClO_3)_2$ (molar mass = 143.1)?

B. PERCENT COMPOSITION

1. A sample was found to contain 2.932 g carbon, 0.7383 g hydrogen and 1.953 g oxygen. Calculate the % by mass of each element in the compound.
   Molar masses: C = 12.011, H = 1.008, O = 15.999

2. Calculate the percent composition of $Al_2(SO_4)_3$.

C. EMPIRICAL FORMULA & MOLECULAR FORMULA

Empirical formula vs. molecular formula:

Calculations

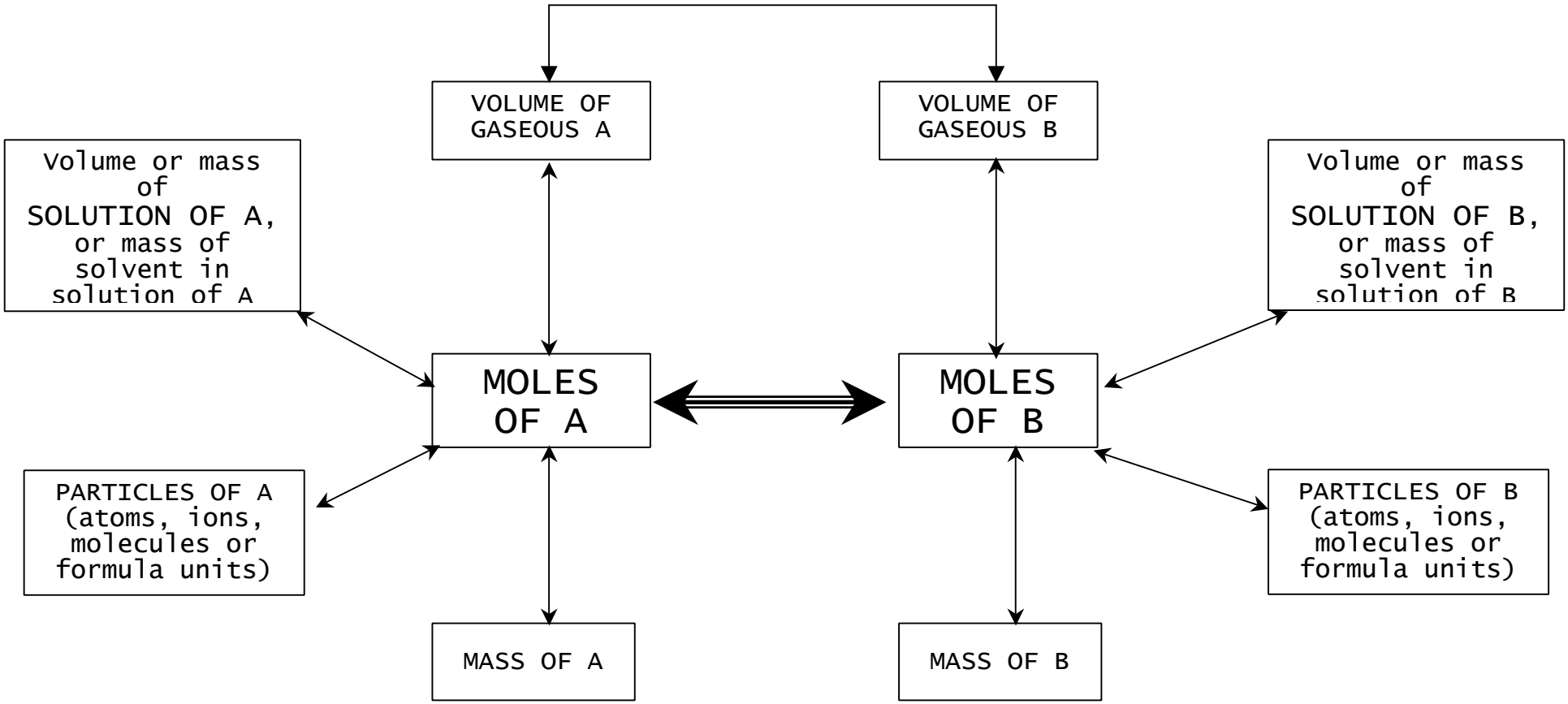
1. A sample of vitamin C was found to contain 1.441 g carbon, 0.1613 g hydrogen and 1.920 g oxygen. What is the empirical formula of vitamin C?

2. A 2.500 g sample of U heated in air produced 2.949 g of an oxide. What is the empirical formula of the oxide?

3. What is the molecular formula of a compound that has a molar mass of 56.11 g/mole and that contains 85.63% by mass carbon and 14.37% by mass hydrogen?

STOICHIOMETRY

A = reactant or product in a given chemical reaction
B = reactant or product in a given chemical reaction



A. SIMPLE STOICHIOMETRY PROBLEMS

1. Use the following equation to answer the following questions:

$$2\ KClO_{3(s)} \rightarrow 2\ KCl_{(s)} + 3\ O_{2(g)}$$

(molar masses: $KClO_3$ = 122.6, O2 = 15.999)

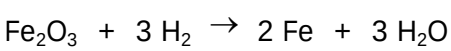
a. How many moles O_2 are produced by the decomposition of 9.80 moles $KClO_3$?

b. How many grams O_2 are produced by the decomposition of 6.50 moles $KClO_3$?

c. How many moles O_2 are produced by the decomposition of 25.0 g $KClO_3$?

d. How many grams of oxygen are produced by the decomposition of 85.2 g $KClO_3$?

2. How many grams of hydrogen are needed to react with 4.75 g Fe_2O_3 (molar mass 159.6)?



$$Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$$

B. LIMITING REACTANT PROBLEMS

If 18.1 g NH_3 is reacted with 90.4 g of CuO, they react according to the equation:

$$2\ NH_3(g) + 3\ CuO(s) \rightarrow N_2(g) + 3\ Cu(s) + 3\ H_2O(l)$$

(Molar masses: NH_3 = 17.0, CuO = 79.6, N_2 = 28.0, H_2O = 18.0)

1. Which is the limiting reactant?
2. What is the maximum amount (in grams) of N_2 that can be produced?
3. Which is the excess reactant and what mass (in grams) will be left over?

C. PERCENT YIELD PROBLEMS

1. Definitions

   a. Theoretical yield

   b. Actual (experimental) yield

   c. Percent yield

2. Consider the reaction:

   $$2\ H_2(g) + CO(g) \rightarrow CH_4O\ (l)$$

   (Molar masses: CO = 28.0, CH_4O = 32.0, H_2 = 2.02)

   If 68.5 g of CO is reacted with 8.60 g of H_2 and 35.7 g of methanol, CH_4O, is actually produced, what is the percent yield of methanol?