CHEMISTRY 111 LECTURE

EXAM I Material
REVIEW

Part 1 NOMEMCLATURE

I. COMPOUNDS- Two or more elements chemically combined in definite proportions.

COMPOUNDS

IONIC COMPOUNDS	MOLECULAR COMPOUNDS
Metal - Nonmetal	Nonmetal-Nonmetal

II Naming Ionic Compounds

BACKGROUND:

A. Metallic Cations - (+ charge)

1. Fixed Charged cations

2. Variable charged cations

B. Nonmetal Anions (-) charge

C. Polyatomic Ions

Naming compounds

Key: Compounds are neutral ⇢ no net charge

III Naming Molecular compounds

Nonmetal - Nonmetal

Variable combinations

Ex.

1. Know prefixes: Di, tri, tetra...etc
2. Naming formula:
   Prefix element #1 + prefix stem of element #2 + ide

Ex.

IV ACIDS AND BASES

Formula starts with a "H" + (aq)
[H_2O is excluded]

Ex. HCl (aq) "Dissolved in water" The HCl must be in H_2O to have the properties of an acid.

ACIDS

- Binary Acid — Does not contain "O"
- Oxyacid/ Ternary Acid — Contains "O"

A. Binary Acids (no "O")

Naming: Hydro + stem of element + ic Acid

Ex.

Exception: H_2S ⇢

B. OXYACIDS/TERNARY ACIDS (contains "O")

Naming Formula:

Ion name But Change ite ⇢ ous / Ate ⇢ ic + Acid

KEY: Recognize the ion part of the Acid

ACID ION

EXCEPTION:

PRACTICE:

Name or give the chemical formula for the following:.

oxalic acid	magnesium hydrogen carbonate
_____	_____
mercurous nitride	ammonium carbonate
_____	_____
silver nitrate	aurous iodide
_____	_____
plumbic acetate	iodine tribromide
_____	_____
calcium peroxide	hydrobromic acid
_____	_____
potassium phosphide	sulfurous acid
_____	_____
nickelous permangante	cobaltous sulfide
_____	_____
CS_2	Co_2O_3
_____	_____
$Ni(NO_2)2$	$Bi(NO_3)_3$
_____	_____
Ba_3N_2	$HClO_3(aq)$
_____	_____
$Ca(OH)_2$	N_2O_5
_____	_____

$Sr(HSO_3)_2$

_____

$Hg(HCO_3)_2$

_____

$H_2CO_3(aq)$

_____

PbO_2

_____

SO_3

_____

_____

HF

_____

$HBrO_2(aq)$

_____

$HC_2H_3O_2(aq)$

_____

Au_3PO_4

_____

N_2O_3

_____

$Cu(ClO)_2$

_____

HCN(aq)

_____

$Al(OH)_3$

_____

Part 2 CHEMICAL FORMULA CALCULATIONS

I. THE MOLE

1 mole = 6.02 x 10^{23} Particles

Avogadro's number → *memorize!!*

Conversions

$$\frac{1 \text{ mole H atoms}}{6.02 \times 10^{23} \text{ atoms}} \quad \text{or} \quad \frac{6.02 \times 10^{23} \text{ H atoms}}{1 \text{ mole atoms}}$$

II. MOLAR MASS (molecular wt.)

1 mole = AMU weight numerically in grams

26
Fe
55.85

Atomic wt.
55.85 AMU
{1 atom}

Molar mass
55.85 g
= 1 mole of Fe atoms
= 6.02 x 10^{23} Fe atoms

IV. MOLES AND CHEMICAL FORMULAS

N_2O_5

2 atoms N
5 atoms O
= 1 molecule N_2O_5

2 mole N
5 moles O
= 1 mole of N_2O_5

Ratios:

Problem:
How many moles of N in 13.5 moles of N_2O_5?

V MOLES AND CHEMICAL CALCULATIONS:

1. How many grams of Zn will combine with 34.00 g of nitrogen?

2. How many atoms of O are needed to produce 32 kg of phosphoric acid?

VI Empirical and Molecular Formulas:

A. Empirical formula shows the smallest ratio of atoms in a compound.
Examples:

B. Calculation of Empirical and Molecular Formula

The percentage composition of a compound is 63.133% C, 8.831% H, and 28.04% O.
The Molar mass = 171.21 g/mol
What is its empirical formula? What is its molecular formula?

STEP 1. Calculate the Empirical Formula

STEP. 2 Calculate the Empirical Formula weight.

STEP. 3 Determine the number of E.F. units in the molecular formula
{ Divide the molar mass by the E.F. wt.}

Part 3 CHEMICAL REACTIONS

A chemical reaction occurs when there is a change in chemical composition.

I. Evidence of a reaction- One of the following would be observed:

a. A precipitate is formed or dissolved
b. A change of color
c. Effervescence occurs (gas formation)
d. Energy in the form of heat, light, or electricity is released

II Types of Chemical Reactions--> Know and complete

A. Combination Reactions - One product is formed:

1. Metal + Nonmetal $\xrightarrow{\text{combines to form}}$ an Ionic compound

2. Metal Oxide + H_2O $\xrightarrow{\text{combines to form}}$ a Base

3. Nonmetal Oxide + H_2O $\xrightarrow{\text{combines to form}}$ an Acid

B. Decomposition-A single reactant will form two or more products

1. Carbonates (CO_3^{2-}) $\xrightarrow{\text{decomposes}}$ to oxides and CO_2(g)

2. Sulfites (SO_3^{2-}) $\xrightarrow{\text{decomposes}}$ to oxides and sulfur dioxide gas

3. Metal oxides $\xrightarrow{\text{decomposes}}$ to metal + Oxygen gas

4. Ionic Compounds $\xrightarrow{\text{decomposes}}$ to Metal + Nonmetal

5. Hydroxides $\xrightarrow{\text{decomposes}}$ to Metal oxides + water

6. Nitrates $\xrightarrow{\text{decomposes}}$ to Nitrites + Oxygen gas

7. Peroxides $\xrightarrow{\text{decomposes}}$ to Oxides + Oxygen gas

8. Chlorates $\xrightarrow{\text{decomposes}}$ to chlorides + Oxygen gas

C. Combustion Reactions involves organic compounds:

General Form: $(C_xH_yO_z) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

D. Single displacement Reactions/ Replacement Rxns.
A more active element displaces a less active element
TYPES:

Type 1: Metal + H_2O → Base + $H_2(g)$

Type 2: Metal + Acid → Salt + $H_2(g)$

Type 3: $Metal_1$ + $Salt_1$ → $Metal_2$ + $Salt_2$

Type 4. $Nonmetal_1$ + $Salt_1$ → $Nonmetal_2$ + $Salt_2$

SOLUBILITY RULES FOR IONIC COMPOUNDS

Ion contained in the Compound	Solubility	Exceptions
Group IA	Soluble	
NH_4^+	Soluble	
$C_2H_3O_2^-$	Soluble	
NO_3^-	Soluble	
Cl^-,Br^-, and I^-	Soluble	Ag^+, Pb^{2+}, Hg_2^{2+}
SO_4^{2-}	Soluble	Ca^{2+},Sr^{2+},Ba^{2+},Pb^{2+}
CO_3^{2-}, PO_4^{3-}, CrO_4^{2-}	insoluble	group IA and NH_4^+
S^{2-}	insoluble	group IA,IIA, and NH_4^+
OH^-	insoluble	group IA, Ca^{2+}, Ba^{2+},Sr^{2+}

STRONG BASES	
LiOH	CsOH
KOH	$Sr(OH)_2$
RbOH	$Ba(OH)_2$
NaOH	$Ca(OH)_2$

STRONG ACIDS	
HNO_3	HCl
$HClO_4$	HBr
H_2SO_4	HI

E. Double Exchange (Ion Exchange) Reactions

1. In a double displacement (ion exchange) reaction, the positive end and negative end of compounds "change partners" to form new products:

a. Precipitate

*Note: A ppt **must** form for the rxn to occur. (if it doesn't...Then NR!)

b. Less Ionized Substance.(Molecule formation)

(1) Gas

(2) Neutralization

(3) A weak acid or base is formed

Part 4 STOICHIOMETRY: CHEMICAL REACTION CALCUATIONS:

The numerical relationship among the reactants and products in a balanced equation (Chemical reaction)

The Balanced equation

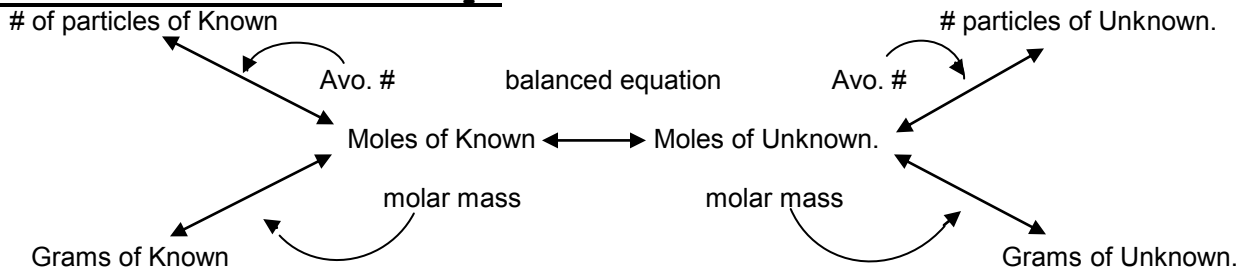
A balanced equation shows a chemical reaction in shorthand:
For example: Two magnesium atoms (a solid) when ignited, reacts with oxygen atoms to form solid magnesium oxide

The meaning of a balanced Chemical Equation: A bookkeeping system

The balanced equation - mole to mole ratios

These mole to mole ratios are exact numbers.

II. The Stoichiometric Pathway:



III. Stoiciometric Calculations

1. The reaction: Chromium metal is reacted with copper (II) chloride

Key: You must have a balanced equation!!

How many grams of chromic chloride reacts with 6.0 mole Cr?

2. How many grams of oxygen gas are required for the complete combustion of 694 g of methane $CH_4(g)$ in a sample of natural gas?

IV. LIMITING REACTANTS

When most reactions are performed, some of the reactants is usually present in excess of the amount needed. If the reaction goes to completion, then some of this *excess reactant* will be left-over. The **limiting reactant** is the reactant used-up completely and it "limits" the reaction.
For example:

PROBLEMS:

1. Zinc nitrate is reacted with sodium hydroxide.

   a. How many grams of Zinc hydroxiode is produced when 13.0 grams of zinc nitrate and 17.0 grams sodium hydroxide are mixed? How much excess reactant is left?

   METHOD: Find the L.R. → *Calculate the moles of product that each reactant may produce.*

   BALANCED EQUATION:

   (1) Find the L.R.

   (3.) Determine the MASS of product made from the L.R.

   (4.) Calculate the grams of excess reactant

VI. PERCENT YIELD

The amount of product that has been previously calculated from chemical equations show the maximum yield (100%). However, many reactions fail to give a 100% yield of product.

The theoretical yield is the calculated amount of product.

The Actual yield is the amount of product actually obtained

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

PROBLEM:

5.000 g of Ag_2S was produced from 5.000 g of Ag and an excess of sulfur according to the reaction:

$$2\ Ag + S \rightarrow Ag_2S$$

What is the percent yield?

WORKSHEET- STOICHIOMETRY AND CHEMICAL FORMULA CALCUATIONS

SET A: (Time required, 1 hour)

1) A compound with the formula, $B_xH_{20}O_3$, contains 36.14 % by mass oxygen. What is the value of the integer, x ?
Ans: x = 6

2) A mixture of cobalt(II) oxide and cobalt(III) oxide contains 32.50 % by mass cobalt (II) oxide. What is the total number of oxide ions in a 122 g of the mixture?
Ans: 1.22×10^{24} oxide ions

3.) A sulfur containing compound is treated chemically to convert all its sulfur into barium sulfate. A 8.19 mg sample of the compound gave 5.46 mg barium sulfate.

a) What is the percentage of sulfur in the compound?
Ans: 9.18 % S

b) If there is one sulfur atom in the molecule, what is the molar mass of the compound ?
Ans: 349 g/mole

4) An alloy of Co, Rh and Mn contains these elements in the atomic ratio of 2 : 5 : 2 , respectively. What is the mass of a sample of this alloy containing a total of 8.75×10^{21} atoms ?
Ans: 1.20 g

5) The percent of aluminum in the compound, Al_2X_3, is 18.56 %. What is the molar mass of element X ?
Ans:79.00 g/mole

6) 3.9104 g sample of a compound made of carbon, hydrogen, nitrogen, and oxygen is burned completely. 3.820 g CO_2 and 3.125 g H_2O are produced.
Analysis of nitrogen showed that the compound contains 46.62 % by mass nitrogen. The molar mass of the compound is about 170 + 15 g/mole.

a) Calculate the empirical formula of the compound. 6a) Ans: $C_2H_8N_3O$

b) What is the molecular formula of the compound? 6b) Ans: $C_4H_{16}N_6O_2$

7) 169 g $FeCr_2O_4$, 298 g K_2CO_3 and an excess of O_2 (g) are sealed in a reaction vessel and allowed to react at high temperature. The amount of K_2CrO_4 obtained is 194 g. Calculate the percent yield of K2CrO4.

$$4\ FeCr_2O_4 + 8\ K_2CO_3 + 7\ O_2 \rightarrow 8\ K_2CrO_4 + 2\ Fe_2O_3 + 8\ CO_2$$

(Molar mass: $FeCr_2O_4$ = 223.84, K_2CO_3=138.21, K_2CrO_4 =194.19 g/mole)

Ans: 66.2 %

SET B: (time required, 1 hour)

1) Excess amount of HCl is added to a mixture of $CaCO_3$ and K_2CO_3. The mixture reacted completely.

$$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2O + CO_2$$
$$K_2CO_3 + 2\ HCl \rightarrow 2\ KCl + H_2O + CO_2$$

4.48 g CO2 and 3.57 g KCl are produced along with some $CaCl_2$ and H_2O. Calculate the mass of the mixture.
Ans: 11.10 g mixture

2) The percent of manganese in the compound, Mn_5X_2, is 42.10 %. What is the molar mass of element X ?
Ans: 186.9 g/mole

3) A mixture of potassium phosphate and potassium nitrate contains 36.55 % by mass potassium nitrate. What is the total number of potassium ions in 83.5 g mixture?
Ans: 6.32×10^{23} ions

4) A carbon containing compound was treated chemically to convert all its carbon into $SrCO_3$. A 31.23 g sample of the compound gave 1.203×10^2 g $SrCO_3$.
a) What is the percentage of carbon in the compound? 4a) ans 31.3 % C
b) If there are three carbon atoms in a molecule of the compound, what is the molar mass of the compound?
Ans: 114.8 g/mole

5) 80.0 g $KClO_3$ are mixed with 59.5 g HCl and allowed to react according to the equation:

$$2\ KClO_3 + 4\ HCl \rightarrow 2\ KCl + 2\ ClO_2 + Cl_2 + 2\ H_2O$$

(Molar mass: KCl = 74.6, $KClO_3$ = 122.6, HCl = 36.5, ClO_2= 67.5, Cl_2 = 71.0, H_2O = 18.0 g/mole)
The amount of Cl2 produced is 18.7 g. Calculate the percent yield of Cl_2.
Ans: 80.6 %

6) 28.50 g sample of a compound of carbon, sulfur, hydrogen, and oxygen is burned. 35.25 g CO_2 and 14.65 g SO_2 are produced. Analysis of hydrogen showed that the compound contains 8.514 % hydrogen by mass. The molar mass of the compound is 500 + 5 g/mole.
a) Calculate the empirical formula of the compound. 6a) Ans:$C_7H_{21}S_2O_5$
b) What is the molecular formula of the compound? 6b) Ans: $C_{14}H_{42}S_4O_{10}$

SET C:

1) A phosphorus containing compound is treated chemically to convert all its phosphorus into $Mg_3(PO_4)_2$. A 7.88 g sample of the compound gave 4.75 g $Mg_3(PO_4)_2$. What is the percentage by mass of phosphorus in the compound?
Ans: 14.2 % P

2) The percent by mass of boron in the compound, B_7X_3, is 42.1 % . What is the molar mass of X ?
Ans: 34.7 g/mole

3) A 39.11 g sample of a compound containing Cr is analyzed to show the presence of 86.22 % Cr. It is found that there are five chromium atoms per molecule of the compound. What is the molar mass of the compound?
Ans: 301.6 g/mole

4) The percent by mass of silicon in the compound, Si_8X_3, is 72.33 %. What is the molar mass of element X ?
ans: 28.65 g/mole

5) Consider the following reaction:

$$3\ CaBr_2 + 2\ Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ NaBr$$

A reaction mixture contained 22.44 g of $CaBr_2$ and 16.85 g Na_3PO_4.
(Molar mass: $CaBr_2$ = 199.9, Na_3PO_4 = 164.0, $Ca_3(PO_4)_2$ = 207.2, NaBr = 102.9 g/mole)

a) What is the mass of $Ca_3(PO_4)_2$ produced after the reaction is complete ?
Ans: 7.753 g

b) How many grams of each reactant is left after the reaction is complete?
Ans: zero grams of $CaBr_2$ and 4.58 g Na_3PO_4