

# EXAM I MATERIAL

## Chapter 4-Atoms and Elements, continued

### I Ions

### II ISOTOPES-Tools

#### A. Tools

1. Atomic number,  $Z$ , equals the number of protons
2. Mass number,  $A$ , equals the sum of protons and neutron (nucleons)
3. Electrons,  $e^-$ , equals the number of protons in a neutral atom
4. Subatomic Particles =  $e^-$ ,  $p^+$ ,  $n$

### Summary:

**Remember:** opposites attract

B. Atomic Isotopes - Atoms with the same atomic number (# p<sup>+</sup>), but different number of neutrons

→ Different mass

Examples:

| Isotopic Symbol | Mass #, A | Atomic #, Z | # p <sup>+</sup> | # n | % natural abundance |
|-----------------|-----------|-------------|------------------|-----|---------------------|
| N-14            |           |             |                  |     |                     |
| N-12            |           |             |                  |     |                     |
| N-13            |           |             |                  |     |                     |

Atomic Isotopes - Problems:

1. Give the isotopic symbol for an atom of Be that has the same number of p<sup>+</sup>, n, and e<sup>-</sup>

2. Find the number of protons, neutrons and electrons in Ne-22

C. IONS-Ions are atoms with a charge

IONS

ANIONS

CATIONS

Ion-Problem

1. a. Calculate the number of protons, electrons and neutrons of an N-14 atom that has a -3 charge.

b. How many subatomic particles does this ion have?

# Chapter 5-Molecules and Compounds

## CHEMICAL FORMULAS – HOW TO REPRESENT COMPOUNDS

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

### COMPOUNDS

#### IONIC COMPOUNDS

Metal - Nonmetal

#### MOLECULAR COMPOUNDS

Nonmetal-Nonmetal

## **II. Ionic compounds**

Formation of ions:

Metals form cations (+) ions:

Nonmetals form Anions (-) ions:

## **III. Cation and Anions**

A. Metallic Cations - (+ charge)

1. Fixed Charged cations are those metals that form only one type of ion.

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# PERIODIC TABLE IA

2. Variable charged cations are those metals that form more than one type of ion.

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# PERIODIC TABLE IA

B. Nonmetal Anions (-) charge

The image shows a blank periodic table grid. It consists of a main body with 7 rows and 18 columns. The first row has 2 cells, the second and third rows have 2 cells each, the fourth through sixth rows have 18 cells each, and the seventh row has 3 cells. Below this main body is a separate block consisting of two rows of 14 cells each, representing the lanthanide and actinide series.

# PERIODIC TABLE IA

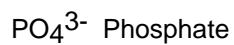
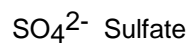
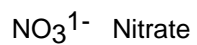
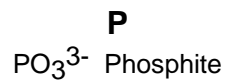
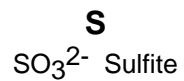
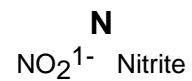
## IV. Naming Ionic Compounds

1. Fixed metal → name as is

2. Variable charged metal- remember the (roman numeral) or use the classical "common" name.

## V. Polyatomic Ions

A group of atoms bonded together to form an ion



## VI. Naming compounds with polyatomic ions

## VII. Chemical Formulas

Key: Compounds are neutral → no net charge

## VIII. Molecular compounds

Nonmetal - Nonmetal

Variable combinations

Ex.

1. Know prefixes:

| Prefix       | Number |
|--------------|--------|
| Mono-        | 1      |
| Di-          | 2      |
| Tri-         | 3      |
| Tetra-       | 4      |
| Penta-       | 5      |
| Hexa-        | 6      |
| Hepta-       | 7      |
| Octa-        | 8      |
| Ennea-/Nona- | 9      |
| Deca-        | 10     |

2. Naming formula:

Prefix element #1 + prefix stem of element #2 + ide

Ex.

## IX. HYDRATES

Ionic compounds that incorporate  $H_2O$  in their crystalline structure (water of hydration)

ex.  $CuSO_4 \cdot 5 H_2O$

## X. ACIDS

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:  $\text{H}_2\text{S}$ -->

B. OXYACIDS (contains "O")

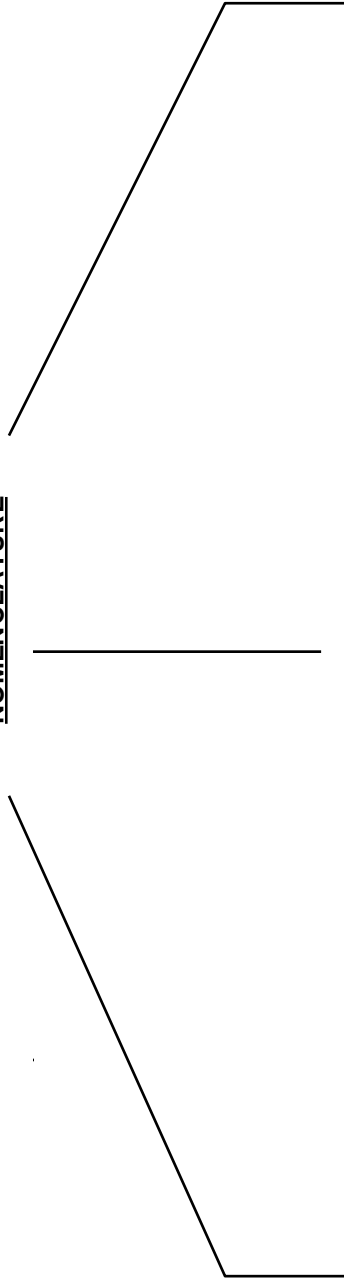
Naming Formula:

Ion name But Change      ite--> ous + Acid  
   ate--> ic

KEY: Recognize the ion part of the Acid

ACID \_\_\_\_\_ ION

NOMENCLATURE



Formula starts with an "H" + (aq)  
(Water is excluded)

ACID

oxyacid contains oxygen  
binary acid does not contain oxygen

EXAMPLES:

HClO hypochlorous acid  
 HCl hydrochloric acid

Metal-Nonmetal

IONIC COMPOUND

Fixed charged metal Group 1A, IIA, Al, Ga, Cd, Zn, or Ag  
 --> name as is

Variable charged metal All other metals  
 --> place charge in ( ) as roman numerals/  
 know classical names

KBr Potassium bromide  
 CuOH Copper (I) hydroxide

Nonmetal-Nonmetal

MOLECULAR COMPOUND

When naming, use prefixes  
 (mono, di tri...etc.)

CO Carbon monoxide

HYDRATES: CONTAINS H<sub>2</sub>O in the chemical formula - use prefix + Hydrate



## Nomenclature Examples

# Chapter 6-CHEMICAL COMPOSITION

## CHEMICAL FORMULA CALCULATIONS

**I. FORMULA WEIGHTS** =  $\sum$  Mass of all atoms  
Atomic level  
one formula unit of  $\text{Al}_2\text{O}_3$  =

## II. THE MOLE

1 mole of particles =  $6.02 \times 10^{23}$  particles  
*Avogadro's number → memorize!!*

### Conversions

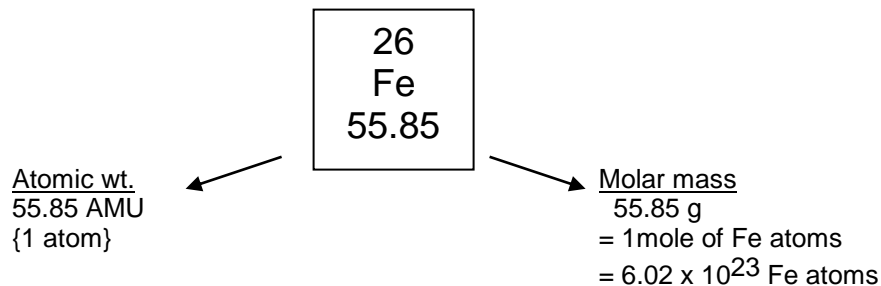
$\frac{1 \text{ mole H atoms}}{6.02 \times 10^{23} \text{ atoms}}$     or     $\frac{6.02 \times 10^{23} \text{ H atoms}}{1 \text{ mole atoms}}$

Problem: How many Cu atoms in 6.0 mol Cu?

Know: 1 mol Cu =  $6.02 \times 10^{23}$  atom

### III. MOLAR MASS (molecular wt.)

1 mole = AMU weight numerically in grams



Conversion factors:

Problems:

1a. How many moles of Fe in 33.0 g of Fe?

b. How many atoms is this?

### IV. MOLECULAR COMPOUNDS AND IONIC COMPOUNDS

### V. MOLES AND CHEMICAL FORMULAS



2 atoms N  
5 atoms O  
= 1 molecule  $\text{N}_2\text{O}_5$

2 mole N  
5 moles O  
= 1 mole of  $\text{N}_2\text{O}_5$

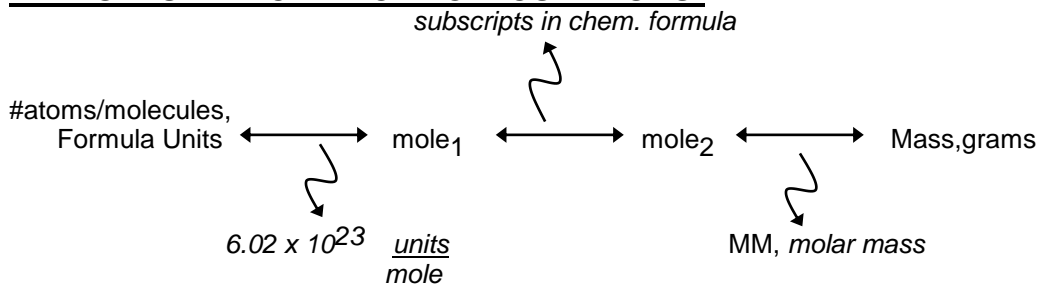
Ratios:

Problems:

1. How many moles of N in 13.5 moles of  $\text{N}_2\text{O}_5$ ?

2. How many moles of O in 13.5 moles of  $\text{N}_2\text{O}_5$ ?

## VI. MOLES AND CHEMICAL CALCULATIONS:



Problems:

1. How many atoms in 13.4 g of S?

2. How many K atoms in 3.0 g K<sub>3</sub>P?

3.  $1.50 \times 10^{25}$  atoms weighed 398.7 g  
a. What is its molar mass?

b. What element is this?

4. What is the **total** number of atoms in 0.20 mole K<sub>3</sub>P?

5. What is the mass in mg of 1 atom of Al?

6. How many atoms of O are in 32 kg of phosphoric acid?

7.

8.

9.

10.

## **VII. PERCENTAGE COMPOSITION**

$$\% \text{ BY WT.} = \left( \frac{\text{WT. of Element}}{\text{Total mass of compound/sample}} \right) \times (100)$$

What is the % composition of NaCl?

## **VIII. EMPIRICAL FORMULA**

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

Examples:

## IX. Calculation of Empirical Formula

Experiment: Elemental Analysis gives %wt of elements

Problem: Find the empirical formula for a compound containing: 11.19 %H and 88.89% O

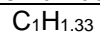
Step 1. Express the percent in grams → Assume 100 g of material.  
IF THE DATA IS ALREADY IN GRAMS GO TO STEP 2!!!

Step 2. Change the grams into moles

Step 3. Change the numbers to whole numbers by dividing by the smallest number.

Problem #2 A 10.00 g sample was analyzed as: 5.293 g Al and the rest is Oxygen. What is its empirical formula?

Multipliers when the simplest mole ratio is not a whole number:



## **X. Calculation of Molecular Formula**

Problem: A compound contains 38.7 % C, 9.7% H, and 51.6 %O. The molar mass of the compound is 62.07 g/mol

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.}

Problem. A 5.00 gram sample contains 4.69 g C and the rest is Hydrogen. It's molar mass is 125 g/mol

# Chapter 9-ELECTRONS IN THE ATOM AND THE PERIODIC TABLE

## I. Electronic Arrangement in Atoms

### A. Background:

Where are the electrons? How do they move? Randomly? Set patterns?

Expt:

Atomic Model- Each electron has a fixed, specific energy due to the distance from the nucleus.

### B. Quantum-Mechanical Orbitals - Electron structure-Section 9.6

#### **Background:**

Electrons in the atoms are found in **principal energy levels (n)** also called shells.

1. In each principal energy level,  $n$ ,  $e^-$  move within orbitals.

Principal energy levels are divided into **sublevels** (or subshells), which consists of **orbitals**.

a. Shapes of orbitals

b. There are  $2 e^-$  per orbital

c. The maximum number of each type of orbitals allowed per Principal Energy level ( $n$ ) and number of electrons in each sublevel (orbital set) are as follows:

| <u>ORBITAL</u> | <u># of orbitals Per Energy Level</u> | $\times 2 e^-/orbital$ | <u>TOTAL # of <math>e^-</math></u> |
|----------------|---------------------------------------|------------------------|------------------------------------|
|----------------|---------------------------------------|------------------------|------------------------------------|

d. Relative Orbital energy.....

(1) within each n value (principal energy level)

(2) for the same type of orbital but different energy levels

(3) within a p "set" of orbitals {same sublevel}

## 2. ELECTRON CONFIGURATION

The filling order of electrons

1.  $e^-$  will occupy the lowest energy orbital possible
2. Orbital Designation
3. Using the periodic table.....
  - a] Period = n for the s & p sublevels  
Period = n-1 for the d sublevel.
  - b] Sublevel {s, p, and d} areas in the periodic table.

c] Obtain the  $e^-$  configuration by going across periods in increasing atomic number (increasing energy)

(1) Each square in the periodic table = 1  $e^-$

(2) Period = Energy level, n, for s and p

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p.....

3. Orbital Diagrams

4. Electron configurations and Orbital diagrams



#### 4. Electron configurations and Orbital diagrams

Examples:

1. O

2. Si

3. Br

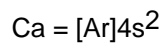
4. Na<sup>+</sup>

5. S<sup>2-</sup>

5. Ne

Mg

d. CORE NOTATION



↑ the "core" must be the previous inert gas

Examples:

## **II. Valence electrons** (High energy electrons)

The electrons in the outermost shell (energy level). Valence electrons are involved in reactions.

(Rem: # valence  $e^-$  = the group number for the "A" subgroup elements)

ex.

## **III. Periodic Trends**

The periodic table can be used to predict certain characteristics of element. These predictions are based upon certain periodic trends.

### A. Atomic Size [Atom Radius]

1. As the number of shells increases, the radius size increases
  
  
  
  
  
  
  
  
  
  
2. As you go left to right across a period, the radius size decreases

Summary

### B. Ionization Energy

The energy required to remove an electron from a neutral atom (in gas phase).

c. Metallic Character The amount of energy released or absorbed when an electron is added to an atom to form a (-) ion [anion], in gas phase.

1. As the number of shells increases, metallic character increases

2. As you go left to right across a period, metallic character decreases

Summary

d. Electron Affinity The amount of energy released or absorbed when an electron is added to an atom to form a (-) ion [anion], in gas phase.

## Chapter 10-CHEMICAL BONDING

CHEMICAL BONDING → The attractive interaction between two atoms or ions

### I. Types: -

1. **Ionic Bond**- Cations (+ charged) and Anions (- charged) are held together by the attractive force of their (+) and (-) charges → Electrostatic force.
2. (Metallic Bonds)
3. (Macro molecular crystals)
4. **Covalent Bonds**- Results from the sharing of a pair of electrons between two atoms.  
ex. CO H<sub>2</sub>O
  - a. Diatomic -
  - b. Polyatomic-

### II. Lewis Electron Dot Structures

1. ▪ = 1 e<sup>-</sup>
2. Shows the number of valence electrons (reacting electrons)
3. Arrange electrons.....

### **III. Octet Rule**

Eight Valence electrons

Atoms react to obtain an "octet" ( 8 valence e<sup>-</sup>)

Anions

Octet rule continued

Cations

**VII. Covalent Bonds** - A bond resulting from one or more shared electron pair(s)

Atoms share electron pairs to form an octet

**Exception:** Hydrogen forms a duet

### **VIII. Multiple Covalent Bonds**

## IX. Complex Electron Dot Structures

### DRAWING ELECTRON DOT STRUCTURES

#### HOW TO:

1. Write e- dot structure for the individual atoms.
2. a) Add together the number of valence electrons for all the atoms  
(If it is an ion, you must add or subtract electrons accordingly)  
  
b) Divide the total number of e<sup>-</sup> by 2: This will give you the number of e<sup>-</sup> pairs available for bonding.
3. Determine which is the central atom
  - a. The least represented atom that is **not H**
  - b. Usually, the **first** atom in the chemical formula that is **not H**.
4. Arrange atoms symmetrically around the central atom.
5. Draw a single line (or 2 dots) between the central and outer atoms.
6. From the total number of valence electrons subtract 2 electron for each bond made.
7. Attempt to place the remaining electron pairs around the outer atoms to make an octet or duet (for H)
8. If an octet cannot be fulfilled; then, a double or triple bond must be formed.  
Warning: Do not use a double or triple bond unless you have to!
9. Each atom (except H) **must** have an octet!

HONC, a general rule (a help)

Examples:

Specific Electron Dot Cases:

a. Ions:

b. Oxy Acids

## **X. Electronegativity and Polarity: Why Oil and Water don't mix Sec. 10.8**

Electronegativity- The ability of an element to attract electrons within a covalent bond

1. Bond Polarity.  
Pure Covalent Bonding

Ionic bonding

Polar covalent bonding

3. Electronegativity

4. Molecular polarity - net polarity of molecules

Type 1-relative electronegativities

- a. Draw individual bond polarities, using relative electronegativity trends or electronegativity numbers
- b. Find the net molecular polarity-using vector analysis by inspection.
- c. If there is a net polarity-the molecule is polar and has a **DIPOLE!**

Type 2 – differences in electronegativity

$\Delta$  EN 0 - .4 = covalent

$\Delta$  EN .4 - 2.0 = polarcovalent

$\Delta$  EN 2.0 + = ionic

Practice EXAM I A**100 POINTS**

**SHOW ALL YOUR WORK. YOUR ANSWERS MUST HAVE THE CORRECT NUMBER OF SIGNIFICANT FIGURES AND UNITS. CORRECT SPELLING MUST BE USED.**

1. COMPLETE THE FOLLOWING TABLE:

| $\begin{matrix} A_{\text{Sym}} \\ Z \end{matrix}$ | Number of protons | Number of neutrons | Number of electrons | Mass number |
|---|-------------------|--------------------|---------------------|-------------|
| _____   | 16                | _____              | 18                  | 32          |
| ${}^{56}\text{Fe}$                                | _____             | _____              | _____               | _____       |

2. Give the isotope symbol for the following:

a. An anion of nitrogen with the same number of neutrons as oxygen-15

b. An iron cation with the same charge and number of subatomic particles as  ${}^{58}\text{Co}^{2+}$

3. Calculate the molar mass of  $\text{Na}_3\text{PO}_4$

4. How many **grams of H** are there in  $3.0 \times 10^{25}$  molecules of  $\text{H}_2\text{SO}_4$ ?

5. 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

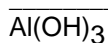
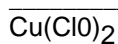
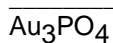
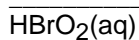
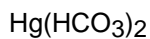
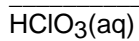
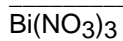
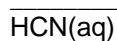
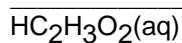
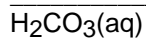
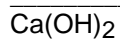
hydrobromic acid

potassium phosphide

sulfurous acid

nickelous permanganate

cobaltous sulfide



6. The percentage composition of a compound is 63.133% C, 8.831% H, and 28.04% O.

The Molar mass = 171.21 g/mol

a. What is its empirical formula?

b. What is its molecular formula?

7. The chemical formula of DDT is C<sub>14</sub>H<sub>9</sub>Cl<sub>5</sub>. In a 0.750 gram sample:

a. How many moles of C<sub>14</sub>H<sub>9</sub>Cl<sub>5</sub> are present?

b. How many grams of carbon are present?

c. What is the total number of atoms present?

d. What is the percent hydrogen in  $C_{14}H_9Cl_5$ ?

8. How many grams of Na has the same number of atoms as 13.0 g N?

9. 1.450 moles of element Y weighs 0.30044 kg.

a. What is the molar mass of Y?

b. What element is this?

10. For the following questions, identify the element whose atoms fit the following descriptions (**Use the periodic table**)

a. \_\_\_\_\_ Which has d electrons?

a) hydrogen    b) Copper    c) nitrogen

b. \_\_\_\_\_ A metalloid in period 5

c. \_\_\_\_\_ The element in period 4, group IIIA

d. \_\_\_\_\_ The element with a total of 3 electrons in the 2<sup>nd</sup> main energy shell

e. \_\_\_\_\_ The element with 5 completely filled orbitals

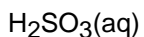
f. \_\_\_\_\_ The smallest alkali metal

g. \_\_\_\_\_ The largest period 4 transition metal

11. a. Write the electron configuration and orbital diagram of a potassium ion

b. Write the electron configuration and orbital diagram of tin

12. Write the electron dot structure for the following compounds



13. Which is larger?

a. B or F?

b. Mg or Sr?

14. Which Has more metallic properties?

a. Na or Cs?

b. Mn or Zn?

15. Is the following bonds (pure) covalent, polar covalent or ionic?
- SO
  - HBr
  - KBr
  - Cl<sub>2</sub>
16. Are the following molecules (pure) covalent, polar covalent or ionic?
- CO
  - O<sub>2</sub>
  - NO
17. Show the polarity of the following molecules:
- HBr
  
  - $\begin{array}{c} \text{H}-\text{S} \\ | \\ \text{H} \end{array}$
  
  - S=C=S

**REMEMBER TO DO THE STARRED PROBLEMS IN THE TEXTBOOK**