CHEMISTRY 101 NOTES: CH. 7: QUANTITATIVE COMPOSITION OF COMPOUNDS pgs. 121-142

The Mole

A mole is a number used to measure a given quantity of a substance (element or compound). This number represents a certain amount of atoms, molecules, or ions and is expressed in one of the following ways:

1.1 Mole = **Avagadro's Number of atoms, molecules, formula units, or ions = 6.022 x 10^{23} atoms, molecules, formula units, or ions. A humungous number!**

2. 1 Mole = the atomic mass (weight) of an element (from the Periodic Table, see number below symbol.)
The atomic weight can be used to convert directly from grams to moles of a substance and vice versa.

Example 1: 10.1 g of Na = ? moles Na

Using the atomic weight (mass) of Na (round to nearest hundredths place),

10.1 g Na x 1 mole Na / 23 .00g Na = 0.44 moles Na

OR to go from moles to grams use the reciprocal

Example 2: 0.25 moles Na = ? g

0.25 moles Na x 23.00 g / 1 mole Na = 5.75 g Na

3. Going from moles to atoms, molecules, formula units, or ions: USE AVOGADRO'S NUMBER.

EXAMPLE 3: 2.2 moles Na = ? atoms Na

2.2 moles Na x (6.022 x 10^{23}) atoms Na / 1 mole Na =

OR to go from atoms to moles, use reciprocal

Example 4: 5.59 x 10^{23} atoms Na = ? moles of Na

(5.59 x 10^{23}) atoms Na x 1 mole Na / 6.022 x 10^{23} atoms =

THE SAME PROCEDURE IS USED FOR MOLECULES, FORMULA UNITS, OR IONS.

DETERMINING MOLAR MASS (Formula Weight or Formula Mass)

1 mole = the mass of each element (from atomic mass) in a given substance added together.

NOTE: The subscript indicates how many of each atom are present and how many times to multiply each atomic mass by.

<u>Example 5</u>: Determine the molar mass of sucrose (table sugar, $C_{12}H_{22}O_{11}$)

Number of C atoms X 12.01 (atomic mass) = 12 x 12.01 g
= 144.12 g C
Number of H atoms x 1.01 = 22 x 1.01 g = 22.22 g H
Number of O atoms x 16.00 = 11 x 16.00 g = 176.00 g O

TOTAL = 144.12 g + 22.22 g + 176.00 g = 342.34 g/mole

This is the molar mass of sucrose.

<u>Example 6</u>: Calculate the molar mass of adamite (alkaline zinc arsenate, $Zn_2(AsO_4)OH$.
Number of Zn atoms = 2, mass of Zn = 2 x 65.39 g = 130.78 g
Number of As atoms = 1, mass of As = 1 x 74.92 g = 74.92 g
Number of O atoms = 5 (4 + 1), mass of O = 5 x 16.00 g = 80.00g
Number of H atoms = 1, mass of H = 1 x 1.01 g = 1.01 g

TOTAL=130.78 g + 74.92 g + 80.00 g + 1.01 g = 286.71 g/mol

<u>PERCENT COMPOSITION</u>: *SEE HANDOUT*.

PERCENT COMPOSITION FROM EXPERIMENTAL DATA

2 Steps: First, given experimental data, determine total mass of all elements present. Next, divide each mass by the total mass from step 1 and multiply by 100.

Example 7: When heated with 3.35 g of Zn, 1.65 g of S burns rapidly and completely to form zinc (II) sulfide. Calculate the % composition of this compound.

Step 1: Total mass = 3.35 g Zn + 1.65 g S = 5.00 g of zinc (II) sulfide

Step 2: %Zn = 3.35 g Zn / 5.00 g Zn X 100 = 67.09% Zn

% S = 100 – 67.09 = 32.91% S

CHECK: %Zn + %S = 100?, 67.09% + 32.91% = 100?

YES! ***Must be 100% to obey Law of Conservation of Mass.***

EMPIRICAL FORMULAS VS. MOLECULAR FORMULAS: ***SEE HANDOUT.***