**Chemistry IA—Chemical Quantities**

- The Mole:

 - MOLE—SI unit of an amount in chemistry

- the mole is a COUNTING unit (just like a dozen)

 - 1 dozen = 12 eggs

 - 1 MOLE = 6.02 x 1023 particles (Avogadro’s number!!)

 - particles can be atoms, ions, molecules or formula units

 - use the FACTOR LABEL METHOD to convert between moles and

 atoms

 **1 mole 6.02 x 1023 atoms**

 **---------------------------- or ------------------------------**

 **6.02 x 1023 atoms 1 mole**

 *How many atoms are in 2.5 moles of C??*

$$\left(\frac{2.5 mol C}{1}\right)\left(\frac{6.02 x 10^{23}atoms C}{1 mol C}\right)=1.5 x 10^{24} atoms C$$

- Molar Mass:

 - molar mass—the mass of 1 mole of a substance (expressed in

 grams)

 - the molar mass is EQUAL in number to the atomic mass in amu

 - it is much more convenient to measure the mass of MOLES of a

 substance because we can measure in grams!!

 - 1 atom H = 1.0079 amu

 - 1 mole H = 6.02 x 1023 atoms H = 1.0079 grams H

 - 1 atom O = 15.9994 amu

 - 1 mole O = 6.02 x 1023 atoms O = 15.9994 grams O

 - FORMULA MASS—the mass of a compound

 - you calculate the formula mass by the ALGEBRAIC SUM of all of

 the atoms making up the compound

 *What is the formula mass of Al2(SO4)3 ??*

Al 🡪 2 x 27.0g = 54.0 g

S 🡪 3 x 32.1g = 96.3 g

O 🡪 12 x 16.0g = 192.0 g

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 342.3 g

 - use the FACTOR LABEL METHOD to convert from moles to mass

 *How many grams are in 2.7 moles of O2?*

$$\left(\frac{2.7 mol O\_{2}}{1}\right)\left(\frac{32.0 g O\_{2}}{1 mol O\_{2}}\right)=86.4 g O\_{2}\rightarrow 86 g O\_{2}$$

 *How many moles are there in 15.5 grams NaCl?*

$$\left(\frac{15.5 g NaCl}{1}\right)\left(\frac{1 mol NaCl}{58.5 g NaCl}\right) = 0.265 mol NaCl$$

- the mole is the CENTRAL UNIT of chemistry!!!!!!

- all conversions usually involve the mole!!!

 **MOLES**

 **Molar**

 **Mass**

 **(grams)**

 **Number**

 **of**

 **particles**

 **(atoms)**

- when converting from grams to atoms or atoms to grams you

 MUST convert to moles first!!

 *How many molecules are in 12.5 grams H2O?*

$$\left(\frac{12.5 g H\_{2}O}{1}\right)\left(\frac{1 mol H\_{2}O}{18.0 g H\_{2}O}\right)\left(\frac{6.02 x 10^{23}molecules H\_{2}O}{1 mol H\_{2}O}\right)$$

$$ =4.18 x 10^{23} molecules H\_{2}O $$

 *How many grams do 5.3 x 1030 molecules of CO2 weigh?*

$$\left(\frac{5.3 x 10^{30}molecules CO\_{2}}{1}\right)\left(\frac{1 mol CO\_{2}}{6.02 x 10^{23} molecules CO\_{2}}\right)\left(\frac{44.0 g CO\_{2}}{1 mol CO\_{2}}\right)$$

$$=3.9 x 10^{8} g CO\_{2}$$

- Percent Composition and Chemical Formulas

 - percent composition—the percent by mass of each element in a

 compound

 mass of element

 % comp = ---------------------------- x 100

 mass of compound

 - can use numbers from given data or use the MOLAR MASSES for

 a known compound

 *Calculate the percent composition of each element in NaHCO3*

**FORMULA MASS = 84.0 g**

$$\% Na= \frac{23.0 g}{84.0 g} x 100= 27.4 \% Na$$

$$\% H= \frac{1.0 g}{84.0 g} x 100= 1.2 \% H$$

$$\% C= \frac{12.0 g}{84.0 g} x 100= 14.3 \% C$$

$$\% O= \frac{48.0 g}{84.0 g} x 100= 57.1 \% O$$

*9.03 g Mg completely combines with 3.48 g N to form a compound. What is the percent composition of this compound??*

***Mg + N2 🡪 MgxNy***

 **9.03g 3.48g 12.51g**

$$\% Mg= \frac{9.03 g}{12.51 g} x 100 = 72.2 \% Mg$$

$$\% N= \frac{3.48 g}{12.51 g} x 100 = 27.8 \% N$$

- Calculating Empirical Formulas:

 - empirical formula—gives the LOWEST WHOLE NUMBER

 RATIO of atoms in the compound

- used for formulas of IONIC compounds

- may or may not be the same as the molecular formula!!

 - Solving for the empirical formula from % composition data:

 STEP 1: Assume 100 g

 STEP 2: Convert % 🡪 g

 STEP 3: Calculate the number of MOLES of each atom

 STEP 4: Divide each number of MOLES by the smallest

 number of MOLES

STEP 5: Make sure that this mole ratio is a WHOLE

 NUMBER RATIO (multiply by different factors until

 it is)

STEP 6: Use the whole number ratio as SUBSCRIPTS in the

 empirical formula

 *A compound is 67.6% Hg, 10.8% S, and 21.6 % O. What is it’s empirical formula??*

**Assume 100 g**

$$67.6\% Hg\rightarrow \left(\frac{67.6 g Hg}{1}\right)\left(\frac{1 mol Hg}{200.59 g Hg}\right)=^{0.337 mol Hg}/\_{0.337}=1$$

$$10.8\% S\rightarrow \left(\frac{10.8 g S}{1}\right)\left(\frac{1 mol S}{32.065 g S}\right)=^{0.337 mol S}/\_{0.337}=1$$

$$21.6\% O\rightarrow \left(\frac{21.6 g O}{1}\right)\left(\frac{1 mol O}{15.999 g O}\right)=^{1.35 mol O}/\_{0.337}=4$$

**So… HgSO4**

- Calculating the molecular formula:

 - molecular formula—shows the actual number of atoms in a

 molecule

- may not be the smallest whole number ratio

- Calculating the molecular formula:

 STEP 1: Calculate the empirical formula

 STEP 2: Divide the MOLAR MASS / empirical formula mass

 STEP 3: Multiply the subscripts in the empirical formula by

 the answer to step 2

 STEP 4: Write the molecular formula using these new

 subscripts

*A compound is 58.8 % C, 9.8 % H, and 31.4% O. It has a molar mass of 102 g/mol. What is the molecular formula???*

**Assume 100 g**

$$58.8\% C\rightarrow \left(\frac{58.8 g C}{1}\right)\left(\frac{1 mol C}{12.011 g C}\right)=^{4.896 mol C}/\_{1.963}=2.5 x 2\rightarrow 5$$

$$9.8\% S\rightarrow \left(\frac{9.8 g H}{1}\right)\left(\frac{1 mol H}{1.00794 g H}\right)=^{9.723 mol H}/\_{1.963}=5 x 2\rightarrow 10 $$

$$31.4\% O\rightarrow \left(\frac{31.4 g O}{1}\right)\left(\frac{1 mol O}{15.9994 g O}\right)=^{1.963 mol O}/\_{1.963} = 1 x 2\rightarrow 2$$

**So… C5H10O2 is the EMPIRICAL**

$\frac{Molar Mass molecule}{Molar Mass empirical}$ **=** $\frac{102 g/mol}{102 g/mol}=1$

**So … {C5H10O2} x 1 🡪 C5H10O2**