COMPOSITION OF COMPOUNDS

MOLE REVIEW

- Molar Mass is the mass of 1 mole of a substance.
- A mole (mol) is the amount of material containing 6.022 X 10^{23} particles.

  1 mol = 6.022 x 10^{23} particles
- A mole is the number necessary to make the number of atomic mass units on the periodic table equal to the mass in grams.
- The mass an atom of an element in amu and of a mole of those same atoms in grams per mole are the same.
- A carbon atom has a mass of 12.01 amu and a mole of carbon atoms (6.022 X 10^{23} atoms C) has a mass of 12.01 g.
- To calculate the molar mass of a compound, add the molar masses of all the atoms making up the compound from the atomic masses on the periodic table.

COMPOSITION OF COMPOUNDS

- Mass percent or mass percent composition can be determined from the molar mass and the atomic masses.
- After adding the molar mass, use the mass each element contributed to the total molar mass and put it over the total molar mass to form a ratio.
- This ratio is multiplied by 100 to indicate the mass percent.
- For $C0_2$, the C is 12.0 g/mol of the total 44.01 g/mol, which would be 27.29% C. The same ratio of masses in grams without the multiplier of 100 can be used as a conversion factor, such as: →

$$\frac{12.01\frac{g}{mol}\text{ of C}}{44.01\frac{g}{mol}\text{ of }CO_2}.$$

- So to find the percent of a substance in a compound:
  1. Find the total molar mass of the compound.
  2. Find the molar mass of the substance being solved for.
  3. Divide the molar mass of the substance by the total molar mass and multiply by 100% (This will give you the percent of the compound that is that substance)

- You can also use this to find the amount of the substance in grams
- To do this:
  1. Take the mass in grams of the entire sample.
  2. Multiply by the percent composition.

- **Example 1:**

How many grams of iron are in 40.00 g of iron(III) sulfate?

The formula mass or molar mass of $Fe_2(SO_4)_3$ is 400.0 g/mol.

$$\frac{111.7\text{ g Fe}}{400.0\text{ Fe}_2(SO_4)_3} \times 100\% = 27.92\%\text{ Fe}$$

$$40.00\text{ g Fe}_2(SO_4)_3 \times 0.2792 = 11.17\text{ g Fe}$$

  - In this problem, the molar mass of iron is divided by the molar mass of iron (III) sulfate and multiplied by 100% to get the percent of the substance that is iron.
  - This percent is then multiplied by the mass of the sample to get the mass in grams of iron in the sample.

- **Example 2:**
  - Chemical formulas can also provide ratios to help solve problems.
  - For instance, in $C_6H_{12}O_6$, the ratio of moles of carbon atoms per mole of compound is 6:1 or 6 mol of C for every 1 mol of $C_6H_{12}O_6$.

How many grams of sulfur are in 40.0 g of $Fe_2(SO_4)_3$?

$$40.00\text{ g} \times \frac{1\text{ mol } Fe_2(SO_4)_3}{400.0\text{ g } Fe_2(SO_4)_3} \times \frac{3\text{ mol S}}{1\text{ mol } Fe_2(SO_4)_3} \times \frac{32.06\text{ g S}}{1\text{ mol S}} = 9.619\text{ g S}$$

  - In this problem, the molar mass of the substance was multiplied by the mass of the sample to get the number of moles contained in the sample.
  - The number of moles of Sulfur in the sample was found to be 3 (This was found by counting the number of sulfur atoms in the chemical formula).
  - The number of sulfur atoms was then divided by the total number of moles in the sample to find the total number of moles of sulfur in the sample.
  - The total number of moles of sulfur was then multiplied by the molar mass of sulfur to find the mass of sulfur contained in the sample.

- **Example 3:**
  - Another ratio sometimes needed in solving problems is the density of the substance.
  - For example, the density of water is 1.00 g/mL.
  - In this case, the ratio of mass to volume can be used to determine the total mass or total volume present.

How many molecules of methanol (CH_3OH) are in 14.8 mL of methanol? The density of methanol is 0.7918 g/mL.

$$14.8\text{ mL } CH_3OH \times \frac{0.7918\text{ g}}{1\text{ mL}} \times \frac{1\text{ mol } CH_3OH}{32.01\text{ g } CH_3OH} \times \frac{6.02 \times 10^{23}\text{ molecules } CH_3OH}{1\text{ mol } CH_3OH}$$
$$= 2.20 \times 10^{23}\text{ molecules } CH_3OH$$

  - In this problem, the density of the sample was multiplied by its volume to find the mass of the sample.
  - This mass was then multiplied by the molar mass of the original sample (which can be found by adding all the molar masses of the atoms present in the compound) giving the number of moles contained in the sample.
  - The number of moles was then multiplied by the equation: 1mol = 6.022×10^{23} (Avogadro's Number) to find the number of molecules in the sample.