Mole

- 1 moles of a substance = _____ representative particles of a substance.
    - *This is Avogadro's number*
    - Representative particles can be:
        1. _____
        2. _____ (2 nonmetals)
        3. _____ (metals + nonmetals/polyatomics)
        4. _____

Converting Moles to Particles – 1 mol = 6.02×10^{23} particles

- **Examples:**
    - How many atoms are there in 0.360 moles of silver?

    - How many moles of magnesium is 1.25×10^{23} atoms of magnesium?

    - How many molecules are in 2.0 moles of chlorine gas?

    - How many moles are in 3.7×10^{25} formula units of potassium chloride?

    - How many moles are contained in 4.65×10^{24} molecules of nitrogen dioxide?

Converting Moles to Volume – 1 mol = 22.4 L

- This relationship is only for gasses at _____
    - Standard Temperature = _____
    - Standard Pressure = _____ or _____
- **Examples:**
    - Determine the volume, in liters, of 0.60 mol sulfur dioxide gas at STP.

    - 75 L of N_2 gas is how many moles?

    - Determine the number of moles in 33.6 L of helium gas.

    - What is the volume of 3.20×10^{-3} mol carbon dioxide gas at STP?

    - What volume, in liters, is 2.5 moles of CO_2 at STP?

Formula Mass (Molar Mass)

- The atomic mass (amu) of an element in grams is the _____ of a _____ of the element.

- To determine the molar mass of a compound you must start with a correct formula.

    o *Remember the rules for naming ionic, molecular and acidic compounds.*

- Add up the masses of all atoms in the compound for the overall molar mass.

- **Examples:**

    o Water

    o Carbon dioxide

    o Sodium bicarbonate

    o Calcium fluoride

    o Phosphorus trichloride

    o Calcium sulfate

Converting Moles to Grams – 1 mol = molar mass

- You must find molar mass!

- **Examples:**

    o How many grams are in 7.20 mol of N_2O_3?

    o How many moles is 28 grams of ammonium phosphate?

    o What is the mass of 9.45 mol of aluminum oxide?

    o How many moles of iron(III) oxide are contained in 92.2 g of pure iron(III) oxide?

    o How many grams is 0.29 mol of K_2S?

The Mole Road Map
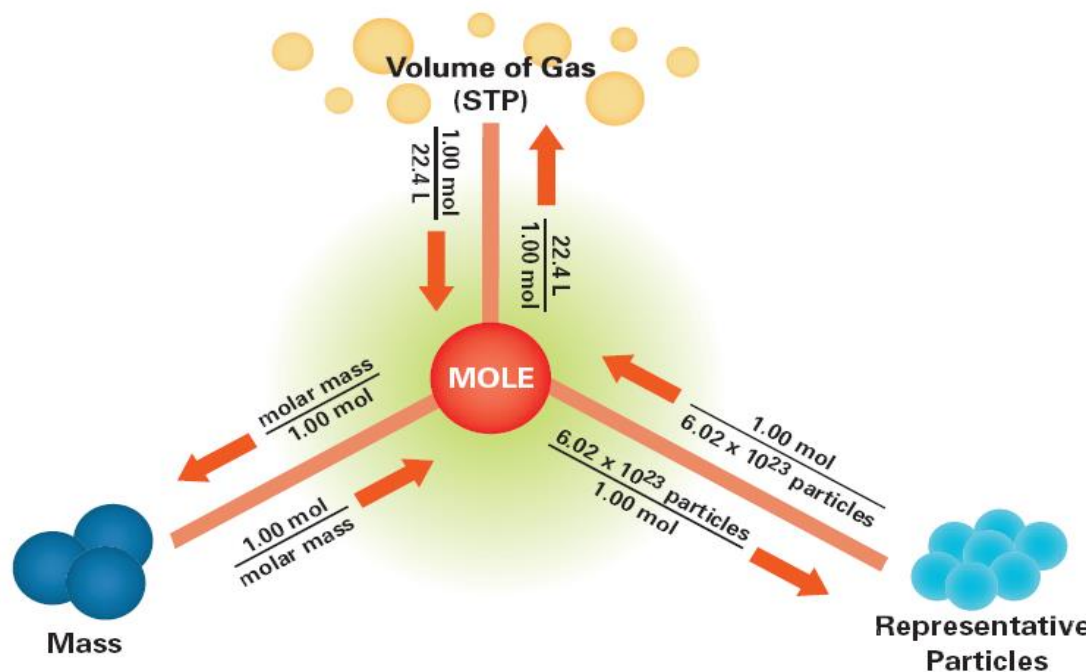
- **Mixed Practice:**
  - Calculate the molar mass of:
    - Sodium sulfate

    - Zinc nitrate

  - Convert the following:
    - 125 g mercury (I) sulfate to moles

    - 1.5×10^{20} molecules of Fluorine gas to moles

    - A sample of NH_3 gas occupies 75.0 liters at standard conditions. How many molecules is this?

    - 0.987 moles of dinitrogen trioxide to grams.

    - 10.5 L of oxygen gas to grams.

Percent Composition

- The relative amounts of each _____ in a _____.
- **Formula:**

$$\% \text{ Mass of Element E} = \frac{\text{Mass of element E (g)}}{\text{molar mass of compound (g)}} * 100$$

- **Examples:**

    1. C_3H_8

    2. HCN

    3. Barium phosphate

    4. When a 13.60-g sample of a compound containing only magnesium and oxygen is decomposed, 5.40 g of oxygen is obtained. What is the percent composition of each element in this compound? *Think about the formula for magnesium oxide…*

    5. Calculate the percent **nitrogen** in these common fertilizers.
        - NH_3

        - NH_4NO_3

Empirical Formulas

- Gives the _____ whole number _____ of atoms (or moles of atoms) of the elements in a compound.

- **Example:** *What is the empirical formula of a compund that is 25.9% N and 74.1% O?*
  - o Steps to find:
    1. Convert mass % to grams. (pretend you have 100 grams)

% to mass

2. Divide by molar mass to get moles.

mass to mole

3. Divide answers from step 2 by smallest # of moles.

÷ by small

4. Multiply to get smallest whole #s. (if unnecessary, jump to step 5)

× til whole

5. Write the empirical formula by putting answers to 3 or 4 as subscripts.

- **Practice:**
  - o Determine the empirical formulas for the following:
    - ▪ 79.9% C, 20.1% H

    - ▪ 67.6% Hg, 10.8% S, 21.6% O

    - ▪ 27.5% C, 1.15% H, 16.09% N, 55.17% O

- 17.1% Na, 39.7% Cr, 42.7% O

- 94.1% O, 5.9% H

Molecular Formulas

- Either the same as the empirical formula, or a simple _____ multiple of the empirical formula.

Comparison of Empirical and Molecular Formulas		
Formula (name)	Classification of formula	Molar mass
CH	Empirical	13
C_2H_2 (ethyne)	Molecular	26 (2 × 13)
C_6H_6 (benzene)	Molecular	78 (6 × 13)
CH_2O (methanal)	Empirical and Molecular	30
$C_2H_4O_2$ (ethanoic acid)	Molecular	60 (2 × 30)
$C_6H_{12}O_6$ (glucose)	Molecular	180 (6 × 30)

- **Example:** *Calculate the molecular formula of a compound whose molar mass is 60.0 g/mol and the empirical formula is CH₄N*
  - Steps to find:
    1. Calculate/determine the empirical formula.

    2. Determine the molar mass of the empirical formula.

    3. Divide the molecular molar mass (usually given in the problem) given by the empirical molar mass.

    4. Multiply the empirical formula subscripts by the value determined in step 3.

- **Practice:**
    1. What is the empirical formula of an unknown compound that has the percent composition of 47.0 % potassium, 14.5 % carbon, 38.5 % oxygen.

    2. If the true molar mass of the above compound is 166.22 g/mol, what is its molecular formula?

    3. A compound with an empirical formula of C_2OH_4 has a molar mass of 88 grams per mole. What is the molecular formula of this compound?

Chapter 10 Mixed Practice

- Convert the following:
    - 2.0×10^{23} molecules of oxygen gas (*formula hint: it's a super 7!*) to liters of gas at STP.

    - 1.45 grams of calcium nitrate to formula units.

    - 0.75 moles of sodium chloride to grams.

- Calculate the percent nitrogen in NH_4NO_3, a common fertilizer.

- Determine the empirical formula for the following:
    - 40.00% C, 6.713% H, and 53.28% O on a mass basis

- The empirical formula of adipic acid is $H_5C_3O_2$. What is the molecular formula if the molecular mass is 146 g/mol?