Percent Composition and Chemical Formulas

Objectives

- Determine the percent composition by mass of elements in a compound
- Differentiate between empirical and molecular formulas
- Calculate the empirical and molecular formulas given percentages

Percent Composition

- $\frac{\text{Mass of element}}{\text{Mass of cmpd}} \times 100$
- If a 13.60 g sample of magnesium oxide is decomposed, 5.40 g of oxygen is obtained.
  - What is the mass of Mg?
  - Calculate the percent composition of each element.

Percent Composition

- $\frac{\text{Mass of element}}{\text{Mass of cmpd}} \times 100$
- If a 13.60 g sample of magnesium oxide is decomposed, 5.40 g of oxygen is obtained.
  - What is the mass of Mg? 8.20 g
  - Calculate the percent composition of each element. O: 39.7%; Mg: 60.3%

- If no numbers are given, use the mass in one mole (molar masses)

- #1: Calculate the percent composition of potassium permanganate, $KMnO_4$.

  K: 24.74%

  Mn: 34.76%

  O: 40.50%

Calculating mass of element

- Problem #1: What is the percentage of carbon in CO_2?
- Problem #2: How many grams of carbon are in 25 g of CO_2?

Calculating mass of element

- Problem #1: What is the percentage of carbon in CO_2?

  27.29% C

- Problem #2: How many grams of carbon are in 25 g of CO_2?

  6.8 g C

Chemical Formulas

- Molecular formula—the actual, chemical formula
- Empirical formula—the simplified version of the molec formula
  - Sometimes molec formulas can't be simplified
- Molec: $C_6H_{12}O_6$, $C_5H_{10}O_5$
- Emp: CH_2O

- What molecular formulas can you create from:
  - CH
  - CH_2

Determining Empirical Formulas

A compound contains 75% carbon and 25% hydrogen. Determine the empirical formula.

1. Turn percentage into grams

   75% C $\rightarrow$ 75 g C

   25% H $\rightarrow$ 25 g H

2. Turn grams into moles

   75 g C $\rightarrow$ 6.2 moles C

   25 g H $\rightarrow$ 25 moles H

3. Divide by smallest # of moles

$\frac{6.2 \text{ moles C}}{6.2} = 1.00$

$\frac{25 \text{ moles H}}{6.2} = 4.03$

4. Use whole numbers for empirical formula CH_4

- Only round when the number is CLOSE

- Calculate the empirical formula for a compound that is 67.6% mercury, 10.8% sulfur, and 21.6% oxygen.
  - $HgSO_4$

Determining Molecular Formulas

- Multiply empirical formula by a whole number to get molecular formula.
- $\frac{\text{Molar mass of molec formula}}{\text{Molar mass of empirical formula}}$

- A compound has the empirical formula HO and a molar mass of 34.0 g/mol. What is the molecular formula?

$$\frac{34.0\ \text{g/mol}}{17.0\ \text{g/mol}} = 2$$

$$HO \times 2 \rightarrow H_2O_2$$

- Calculate the molecular formula of a compound whose molar mass is 60.0 g/mol and empirical formula is CH_4N.
- $C_2H_8N_2$