Chapter 11 Notes #2

PERCENT COMPOSITION, EMPIRICAL AND MOLECULAR FORMULAS.

Percent Composition

- Is the percent *by mass* of each element in a compound.
- Can be determined by dividing the molar mass of each element by the mass of the compound.

Percent Composition

- Consider magnesium chloride ($MgCl_2$)

1. Find the molar mass of each element.
2. Find the molar mass of the compound
3. Divide each elemental mass by the molar mass and convert to percent.

Magnesium = 24.305 g/mol

Chlorine = 35.453 g/mol

$MgCl_2$ = 95.211 g/mol

Percent Composition

$MgCl_2$ = 95.211 Magnesium = 24.305 g/mol Chlorine = 35.453 g/mol

$$\frac{\text{Magnesium}}{MgCl_2} = \frac{24.305}{95.211} = 25.528$$

$$\frac{\text{Chlorine}}{MgCl_2} = \frac{70.906}{95.211} = 74.472$$

Percent Composition

- What is the percent composition of:
- Water? H = 11.2% O = 88.8%
- Sodium nitrate Na = 27.1 N = 16.5 O = 56.5

Empirical Formula

- This is a formula in lowest terms.
- Most of the time formulas are already in lowest terms – organic molecules are notable exceptions.
- The formula for hydrogen peroxide is H_2O_2.
- The empirical formula for hydrogen peroxide is…
- HO

Empirical Formula

- This is a formula in lowest terms.
- Most of the time formulas are already in lowest terms – organic molecules are notable exceptions.
- What is the empirical formula of glucose ($C_6H_{12}O_6$)? Hint: what is the greatest common factor of the subscripts?
- CH_2O

Empirical Formula

- The empirical formula can be determined from the percent composition.
- Divide each element's percent by that element's molar mass. This will give the molar ratios.
- Convert to small whole numbers

Empirical Formula

- Consider a compound known to contain sulfur (40.05%) and oxygen (59.95%).
- Since 100 grams of the substance will contain 40.05 g S and 59.95 g O we will use these units to determine the empirical formula.

$$40.05\ \text{g S} \times \frac{\text{mole S}}{32.065\ \text{g S}} = 1.249\ \text{mol S}$$

$$59.95\ \text{g O} \times \frac{\text{mole O}}{16.0\ \text{g O}} = 3.747\ \text{mol O}$$

Empirical Formula

- Convert to small whole number ratios by dividing all answers by the smallest answer.

These are the subscripts in the formula

$$\frac{40.05\ \text{g S}}{32.065\ \text{g S}} \text{ mole S} = 1.249\ \text{mol S} \quad /1.249\ \text{mol} = 1$$

$$\frac{59.95\ \text{g O}}{16.0\ \text{g O}} \text{ mole O} = 3.747\ \text{mol O} \quad /1.249\ \text{mol} = 3$$

Empirical Formula

- The formula is therefore:
  - SO_3
  - Pg. 333 #50

Molecular Formula

- Once the empirical formula is known, the molecular formula can be determined if the molecular mass is given.
- To do this, simply divide the mass of the molecular formula by the mass of the empirical formula – this will give you the greatest common factor of the molecular formula.

Molecular Formula(Example)

- The empirical of a compound containing phosphorus and oxygen was determined to be P_2O_5. What is its molecular formula if its molecular mass is determined to be 283.89?
- First, determine the mass of the empirical formula.
- P_2O_5 = 141.94 amu

Molecular Formula(Example)

- The empirical of a compound containing phosphorus and oxygen was determined to be P_2O_5. What is its molecular formula if its molecular mass is determined to be 283.89?
- First, determine the mass of the empirical formula.
- P_2O_5 = 141.94 amu
- To determine the greatest common factor, divide this answer into the molecular mass.

Molecular Formula(Example)

- The empirical of a compound containing phosphorus and oxygen was determined to be P_2O_5. What is its molecular formula if its molecular mass is determined to be [redacted]?
- First, determine the mass of the empirical formula.
- P_2O_5 = 141.94 amu

283.89/141.94 = 2

Molecular Formula(Example)

- The empirical of a compound containing phosphorus and oxygen was determined to be P_2O_5. What is its molecular formula if its molecular mass is determined to be 283.89?
- Now that we know the greatest common factor is 2, multiply the subscripts by the GCF to determine the molecular formula.
- $P_{(2}O_{5)2}$

  P_4O_{10}

Pg.355