IDX G10 Chemistry H
Study Guide S1 Midterms

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Contents:

Formula Weights

- Definition: sum of the atomic weights/masses of the atoms in the chemical formula
- Molecular Weight: formula weight of a molecule
    - Unit: amu

Percentage Composition

- percentage of mass contributed by each element in the substance
- $\% \, composition = \frac{mass \, of \, element}{mass \, of \, substance} \times 100\%$

Avogadro's Number (N)

- 1 mole (mol): a unit for measuring the number of microscopic particles
- Value of Avogadro's number: 6.022×10^{23}
    - 1 mol H_2O molecules = 6.022×10^{23} H_2O molecules

Masses, Molar Mass, and Numbers of Particles

- 1 mole of different substances will contain the same number of particles but different masses proportional to formula weights
- The concept of moles provides a bridge between mass and number of particles:
    - $m \underset{\times M}{\overset{\div M}{\rightleftarrows}} n \underset{\div N}{\overset{\times N}{\rightleftarrows}} \#$
- m: mass, n: number of moles, #: number of particles, N: Avogadro's number
- Molar mass (M): The mass in grams of 1 mol of a substance
    - Numerically equal to molecular weight, but in grams per mol (g/mol)

Empirical Formulas from Analyses

- Empirical Formulas: chemical formulas that only give the ratio of moles (percentage composition) of each element in a molecule
- Thus, the EF of a substance can be found through moles
    - $\% \xrightarrow{\text{assume 100-g sample}} m \xrightarrow{\div M} n \xrightarrow[\text{smallest } n]{\text{compare to the}} \text{EF}$
    - The calculated values for mole ratio should be rounded to appropriate whole numbers
        - Non-whole number ratios should be multiplied by a factor that converts them into whole numbers
            - E.g., 1:2.5 = 2:5, 1:1.33 ≈ 3:4
    - E.g., 11.1% H, 88.9% O by mass in the sample

        → 11.1g H, 88.9g O -> 11.1mol H, 5.6mol O

        → H:O = 11.1:5.6 = 11.1/5.6:5.6/5.6 = 1.98:1 ≈ 2:1

        → H_2O (empirical formula)

Molecular Formulas from Empirical Formulas

- The subscripts of MF are always whole-number multiples of the subscripts of EF
    - This multiple is found by dividing the molecular weight by the EF weight
    - E.g., molecular weight = 60 g/mol, empirical formula CH_2O (EF weight = 30 g/mol).

        → whole-number multiple = 60/30 = 2

        → $C_2H_4O_2$ (molecular formula)

Combustion Analysis

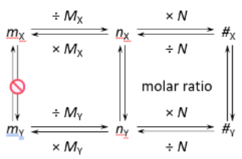
- Technique for determining EF in the lab (commonly used for hydrocarbon compounds)

- $C_xH_y + O_2 \rightarrow H_2O + CO_2$
- Calculate the # of moles of C and H in the original sample with the moles of H_2O and CO_2
- If a third element is present ($C_xH_yO_z$), its mass can be determined by subtracting the measured masses of C and H from original sample mass

Quantitative Info from Equations

- $2H_2 + O_2 \rightarrow 2H_2O$
  - 2 moles of H_2 reacts with 1 mole of O_2 to produce 2 moles of H_2O
- Stoichiometrically equivalent quantities: the quantity of moles given by coefficient
  - E.g. **2 mol** H_2, **1 mol** O_2, **2 mol** H_2O
  - Their relationship can be represented as 2 mol $H_2 \mathrel{\widehat{=}}$ 1 mol $O_2 \mathrel{\widehat{=}}$ 2 mol H_2O
  - $\mathrel{\widehat{=}}$: "is stoichiometrically equivalent to"

Stoichiometric Relationships

- For a balanced equation involving X and Y:
  - 

- These relationships are used to solve mass-mass problems

Limiting Reactants

- Definition: reactant that is completely consumed in a reaction
- Excess reactants: other reactants that are consumed
- Determining the limiting reactant by finding this ratio for each reactant:
  - Number of moles divided by coefficient
  - The substance with the smallest ratio is the limiting reactant

Theoretical Yields

- Definition: quantity of product calculated to form when all of a limiting reactant is consumed
- Actual yield: amount of product actually obtained
  - It is almost always less than but never greater than the theoretical yield because:

        - Reactants do not fully react
        - Side reactions other than the desired reaction occurs
        - Not all of the product can be recovered from mixtures
        - Chemistry is a natural science
- Percent yield: $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$

Electrolyte

- Solutions
    - Homogeneous mixtures of two or more pure substances
    - Solvent — the substance present in greatest abundance
    - Solute — the substance dissolved in the solvent
- Dissociation: when an ionic substance dissolves in water, the polar water molecules pull individual ions from the crystal and solvates them
- Electrolyte: a substance that, when dissolved in water, results in a solution containing ions and conducts electricity
- Non-electrolyte: substance that doesn't form ions and doesn't conduct electricity in a solution
    - Most molecular substances
- Strong electrolytes fully ionize in water, dissociating to ions completely or nearly completely
    - Good conductors
    - All water-soluble ionic compounds are strong electrolytes
    - Some molecular compounds are strong electrolytes (e.g., strong acids like)
- Weak electrolytes only partially ionize, and exist in solutions mostly in the form of molecules, with only a fraction as ions
- Solvation: process in which an ion is surrounded by water molecules arranged in a specific manner
- Double arrow: reversible reactions, showing a chemical reaction that can go both forwards and backwards