CHE1031 Lecture 3: Composition of substances and solutions summary

3.1: Formula mass and the mole concept

The **formula mass** of a substance is the sum of the average atomic masses of each atom represented in the chemical formula and is expressed in atomic mass units. The formula mass of a covalent compound is also called the **molecular mass**. A convenient amount unit for expressing very large numbers of atoms or molecules is the **mole**. Experimental measurements have determined the number of entities composing 1 mole of substance to be **6.022 E23**, a quantity called **Avogadro's number**. The mass in grams of 1 mole of substance is its **molar mass**. Due to the use of the same reference substance in defining the atomic mass unit and the mole, the formula mass (amu) and molar mass (g/mol) for any substance are numerically equivalent (for example, one H_2O molecule weighs approximately18 amu and 1 mole of H_2O molecules weighs approximately 18 g).

3.2: Determining empirical and molecular formulas

The chemical identity of a substance is defined by the types and relative numbers of atoms composing its fundamental entities (molecules in the case of covalent compounds, ions in the case of ionic compounds). A compound's **percent composition** provides the mass percentage of each element in the compound, and it is often experimentally determined and used to derive the compound's **empirical formula**. The empirical formula mass of a covalent compound may be compared to the compound's **molecular or molar mass** to derive a **molecular formula**.

3.3: Molarity

Solutions are homogeneous mixtures. Many solutions contain one component, called the **solvent**, in which other components, called **solutes**, are **dissolved**. An **aqueous solution** is one for which the solvent is water. The **concentration** of a solution is a measure of the relative amount of solute in a given amount of solution. Concentrations may be measured using various units, with one very useful unit being **molarity**, defined as the number of moles of solute per liter of solution. The solute concentration of a solution may be decreased by adding solvent, a process referred to as **dilution**. The dilution equation is a simple relation between concentrations and volumes of a solution before and after dilution.

3.4: Other units for solution concentrations [***optional***]

In addition to molarity, a number of other solution concentration units are used in various applications. **Percentage concentrations** based on the solution components' masses, volumes, or both are useful for expressing relatively high concentrations, whereas lower concentrations are conveniently expressed using **ppm or ppb** units. These units are popular in environmental, medical, and other fields where mole-based units such as molarity are not as commonly used.