Unit 3: Stoichiometry

Introduction to Stoichiometry Mathematics

Rudimentary mathematics forms the foundation for advanced chemical reactions that rely on problem-solving skills. In stoichiometry, the atomic weight signifies the average mass of an element's atoms, crucial for understanding reactions. Molecular weight quantifies the total mass of atoms within a molecule, aiding in mole-based calculations. Formula weight, akin to molecular weight, applies to ionic compounds and plays a vital role in stoichiometry. Percent composition reveals elemental proportions in compounds, informing their properties and behavior. Moles (n) count atoms or molecules, bridging the microscopic-macroscopic divide, while molar mass (M) quantifies one mole's mass, facilitating precise comparisons. Avogadro's Number (6.022×10^{23}) links these scales, defining the quantity of particles in a mole and enabling quantitative chemistry. These concepts underpin scientific understanding and experimentation in chemistry and stoichiometry.

1. What unit is commonly used to express atomic weight? What is the weight of a neutron? A proton? An electron?

2. Calculate the atomic weight of an element if it has 8 protons, 8 neutrons, and 8 electrons.

3. The following questions relate to the weight of a compound.
    a. What does the molecular weight of a compound represent?
    b. What does the formula weight of a compound represent?

4. Calculate the mass percent composition of carbon (C) in carbon dioxide (CO_2).

5. How many moles of water (H_2O) are present in 36 grams of water?

6. How many atoms are there in 2 moles of carbon (C)?

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ChemTalk

ANSWER KEY

1. What unit is commonly used to express atomic weight?

Atomic mass units (amu). Atomic weight is typically expressed in atomic mass units (amu), which are a relative measure of an atom's mass compared to the mass of a carbon-12 atom. The weight of a neutron is 1 amu, the weight of a proton is 1 amu, and the weight of an electron is ~0 amu, its mass is negligible compared to neutrons and protons.

2. Calculate the atomic weight of an element if it has 8 protons, 8 neutrons, and 8 electrons.

The atomic weight is the sum of the protons and neutrons in the nucleus. Remember, neutrons and protons both have a mass of 1 amu, and electrons have negligible mass. In this case, it is 8 protons + 8 neutrons = 16 amu.

3. The following questions relate to the weight of a compound.
    a. What does the molecular weight of a compound represent?
    b. What does the formula weight of a compound represent?

a) The mass of one molecule of the compound. Molecular weight is the sum of the atomic weights of all atoms in a molecule, representing the mass of one molecule of the compound in atomic mass units (amu).

b) The number of moles of the compound. Formula weight represents the mass in grams of one mole of a compound, making it equivalent to the molar mass when expressed in grams/mol.

4. Calculate the mass percent composition of carbon (C) in carbon dioxide (CO_2).

Carbon dioxide (CO_2) consists of 1 carbon atom and 2 oxygen atoms.
The molecular weight of CO_2 is:
12.01 g/mol (for carbon) + 2 * 16.00 g/mol (for oxygen) = **44.01 g/mol**.
To find the percent composition of carbon, divide the mass of carbon (12.01 g/mol) by the molecular weight of CO_2 (44.01 g/mol) and multiply by 100%:
(12.01 g/mol carbon / 44.01g/mol CO_2) * 100% = **27.28%**.

5. How many moles of water (H_2O) are present in 36 grams of water?

To calculate the number of moles, you can use the formula:
Moles (n) = Mass (g) / Molar Mass.
The molar mass of water (H_2O) is approximately 18.02 g/mol
[(2 * 1.01 g/mol for hydrogen) + 16 g/mol for oxygen].
So, Moles (n) = 36 g / 18.02 g/mol = **2 moles of water.**

6. How many atoms are there in 2 moles of carbon (C)?

Avogadro's number tells us that there are approximately $6.022 * 10^{23}$ entities (in this case, atoms) in one mole of carbon. Therefore, in 2 moles of carbon, there are:

$2 * 6.022 \times 10^{23}$ atoms, which is roughly **1.2044×10^{24} atoms**.