Chapter 3: Stoichiometry: Calculations With Chemical Formulas and Equations

- atoms are neither created nor destroyed during any chemical reaction
- **stoichiometry –** quantitative nature of chemical formulas and chemical reactions

3.1 Chemical Equations

- chemical equations **–** the way chemical reactions are represented
- **reactants** – starting substances
- **products –** substances produced from a reaction
- **balanced equation** – equation with equal atoms on both sides of the equation
- subscripts should never be changed in balancing an equation
- coefficients changes only the amount and not identity of the substance

3.2 Patterns of Chemical Reactivity

3.2.1 Using the Periodic Table

- periodic table can be used to determine reactivity of substances
- all alkali metals react with water to form their hydroxide compounds and hydrogen

3.2.2 Combustion in Air

- rapid reaction that produces a flame
- most combustion reactions in air involve oxygen
- hydrocarbons and related compounds produce CO_2 and H_2O during combustion

3.2.3 Combination and Decomposition Reactions

- combination reactions two or more substances react to form one product
- decomposition reaction one substance produces two or more substances

3.3 Atomic and Molecular Weights

3.3.1 The Atomic Mass Scale

- **atomic mass unit (amu)** – unit in measuring mass of atoms
- 1 amu = $1.66054*10^{-24}$g and 1 amu = $6.02214*10^{24}$amu

3.3.2 Average Atomic Masses

- **atomic weight –** average atomic mass

3.3.3 Formula and Molecular Weights

- **formula weight** – sum of the atomic weights of each atom in its chemical formula
- **molecular weight –** same as formula weight

3.3.4 Percentage composition from Formulas

- ((atoms of element)(AW)/(FW of compound) * 100

3.3.5 The Mole

- **avogadro's number** – $6.02*10^{23}$ atoms
- **molar mass –** numerically equal to its formula weight

- grams <use molar mass> moles <use avogadro's number> molecules

3.5 Empirical Formulas from Analyses

- empirical formula gives relative number of atoms in each element
- **mass % elements** >>> assume 100g sample >>> **grams of each element** >>> use atomic weights >>> **moles of each element** >>> calculate mole ratio >>> **empirical formula**
- "percent to mass, mass to mol, divide by small, multiply 'til whole/"

3.5.1 Molecular Formula from Empirical Formula

- the subscripts in the molecular formula of a substance are always a whole-number multiple of the corresponding subscripts in its empirical formula

3.5.2 Combustion Analysis

3.6 Quantitative Information from Balanced Equations

- the coefficients in a balanced chemical equation can be interpreted both as the relative numbers of molecules involved in the reaction and as the relative numbers of moles
- *stoichiometrically equivalent quantities*
- grams reactant >> moles reactant >> moles product >> grams product
- **grams of substance A** >> use molar mass of A >> **moles of substance A** >> use coefficients of A and B from balanced equation >> **moles of substance B** >> use molar mass of B >> **grams of substance B**

3.7 Limiting Reactants

- **limiting reactant** – limits the amount of product formed

3.7.1 Theoretical Yields

- theoretical yield – the amount of product that is calculated to form
- actual yield – the amount of product actually formed

$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$