Chemical Reactions and Stoichiometry

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Topics covered

- Molecular weight and Molar Mass
- Representation of Compounds
- Types of Chemical Reactions
- Net ionic Equations
- Balancing Equations
- Applications of Stoichiometry
- Limiting Reactants

Compounds

- **Compound** – pure substance that is composed of two or more elements in a fixed proportion

- All elements, except some of the noble gases, can react with other elements to form compound

Molecular weight and Molar mass

- A **molecule** is a combination of two or more atoms held together by covalent bonds.
- The **molecular weight** is simply the sum of the weights of the atoms that make up the molecule
- MOLAR MASS = MOLECULAR WEIGHT
- Number of moles = weight of sample (g) / molar mass(g/mol)

Representation of compounds

- **Law of Constant Composition** – any sample of a given compound will contain the same elements in the identical mass ratio
- **Empirical formula** gives the simplest whole number ratio of the elements in the compound.
- The **molecular formula** gives the exact number of atoms of each element in a molecule of the compound

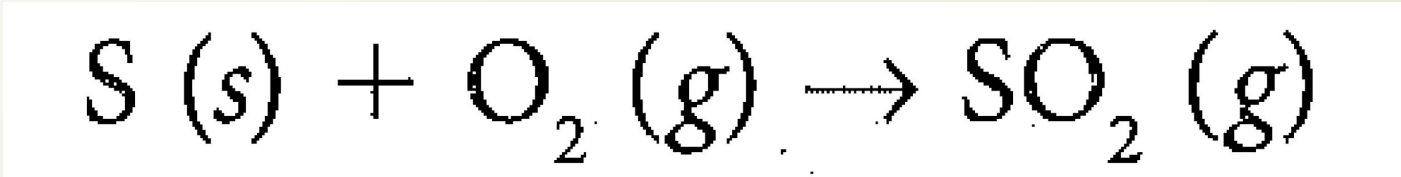
Percent composition

- It is the weight percent of the element in a specific compound.

$$\% \text{ composition} = \frac{\text{mass of X in formula}}{\text{formula weight of compound}} \times 100\%$$

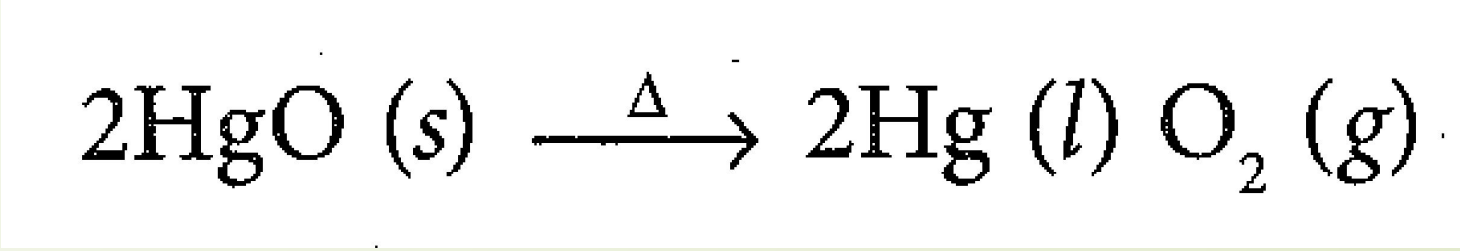
Types of chemical reactions

- 1. Synthesis Reactions
- Two or more reactants form one product



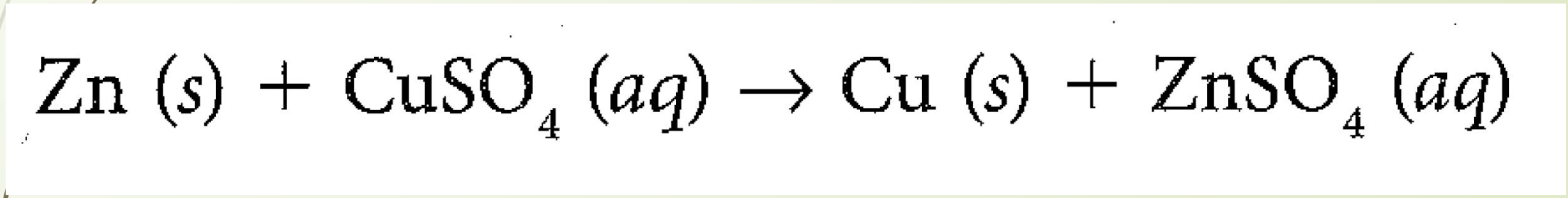
Types of chemical reactions

- 2. Decomposition Reactions
- One in which a compound breaks down into two or more substances, usually as a result of heating



Types of chemical reactions

- 3. Single Displacement Reactions
- An atom of one compound is replaced by an atom of another element



Types of Chemical Reactions

- 4. Double Displacement Reactions
- Elements from two different compounds displace each other to form two new compounds

$$CaCl_2\ (aq) + 2AgNO_3\ (aq) \rightarrow Ca(NO_3)_2\ (aq) + 2AgCl\ (s)$$

Net Ionic Equations

- Because reactions such as displacements often involve ions in a solution, they can be written in **ionic form**
- Very important to demonstrate the actual reaction occurring

$$Zn\ (s) + Cu^{2+}\ (aq) + SO_4^{2-}\ (aq) \rightarrow Cu\ (s) + Zn^{2+}\ (aq) + SO_4^{2-}\ (aq)$$

$$Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Cu\ (s) + Zn^{2+}\ (aq)$$

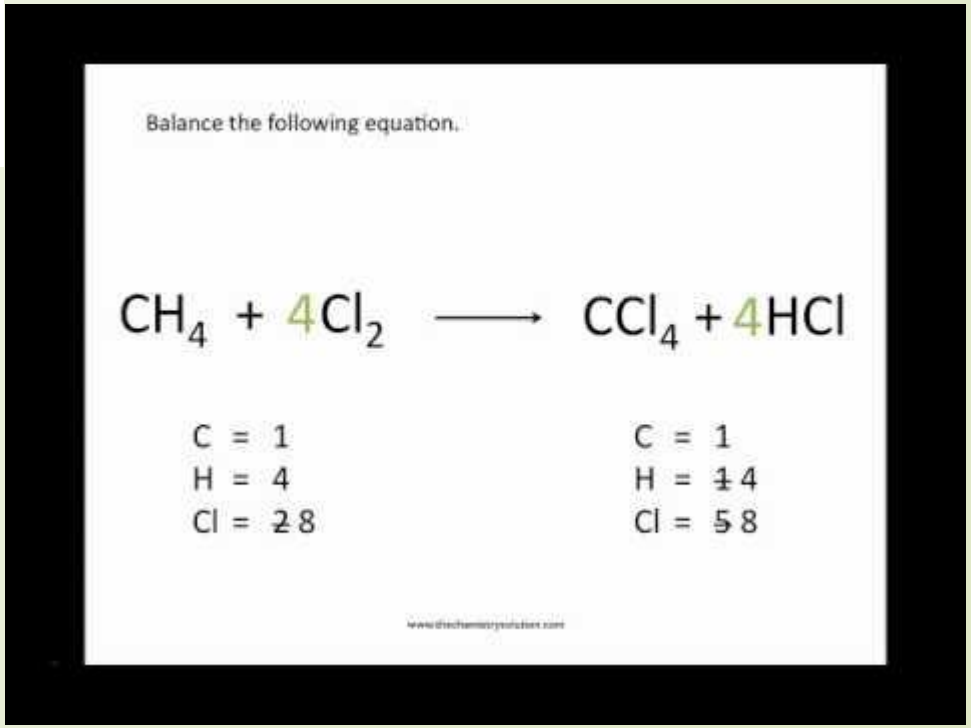
Balancing Equations

- From the **law of conservation of mass**, the mass of the reactants in a reaction must be **equal** to the mass of the products
- **Stoichiometry** is essentially the study of how the quantities of reactants and products are related in a chemical reaction.

Examples of balancing

$2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$

Fe = 4	Fe = 4
O = 6	O = 6
C = 3	C = 3



Applications of stoichiometry

Example: How many grams of calcium chloride are needed to prepare 72 g of silver chloride according to the following equation?

$$CaCl_2\,(aq) + 2AgNO_3\,(aq) \rightarrow Ca(NO_3)_2\,(aq) + 2AgCl\,(s)$$

Limiting Reactants

- **Limiting reactant** limits the amounts of product that can be formed in the reaction
- The reactant that remains after all of the limiting reactant is used up is called the **excess reactant**

Yields

- **The yield of a reaction** is the amount of product predicted or obtained when the reaction is carried out.

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

Summary

THINGS TO REMEMBER

- Molecular Weight and Molar Mass
- Law of Constant Composition
- Empirical and Molecular Formulas
- Percent Composition
- Synthesis Reactions
- Decomposition Reactions
- Single Displacement Reactions
- Double Displacement Reactions
- Net Ionic Equations
- Balancing Equations
- Applications of Stoichiometry
- Limiting Reactants
- Yields