

Basic Chemistry Concepts



Lecture Notes on Dalton's Atomic Theory and Basic Concepts of Chemistry

Dalton's Atomic Theory

Postulates of Dalton's Atomic Theory

1. **All matter is composed of extremely small particles called atoms:** Atoms are indivisible and indestructible particles.
2. **Atoms of a given element are identical:** They have the same size, mass, and chemical properties. Atoms of different elements differ in these properties.
3. **Compounds are formed by a combination of two or more different kinds of atoms:** A given compound always has the same relative number and type of atoms.
4. **A chemical reaction involves the rearrangement of atoms:** Atoms are neither created nor destroyed in a chemical reaction.

Limitations of Dalton's Atomic Theory

1. **Indivisibility of Atoms:** Dalton's theory stated that atoms are indivisible, but later discoveries (like the electron, proton, and neutron) showed that atoms can be divided into smaller particles.
2. **Identical Atoms:** Dalton claimed atoms of the same element are identical in all respects, but isotopes (atoms of the same element with different masses) prove otherwise.
3. **Chemical Reactions:** The theory did not account for the existence of nuclear reactions where atoms of one element can change into atoms of another element.
4. **Nature of Atoms:** Dalton's theory could not explain the internal structure of atoms.

Concept of Atom, Molecule, Element, and Compound

Atom

- **Definition of an Atom:** The smallest unit of an element that retains the chemical properties of that element.
- **Structure of Atom:**
 - **Nucleus:** Contains protons (positively charged) and neutrons (neutral).
 - **Electron Cloud:** Electrons (negatively charged) orbit the nucleus in various energy levels.
- **Atomic Models:**
 - **Dalton's Model:** Solid sphere model.
 - **Thomson's Model:** Plum pudding model (electrons embedded in a positive sphere).
 - **Rutherford's Model:** Nuclear model (small, dense nucleus with electrons orbiting around it).
 - **Bohr's Model:** Electrons orbit the nucleus in fixed energy levels.
 - **Quantum Mechanical Model:** Electrons exist in orbitals, regions of space around the nucleus.

Molecule

- **Definition of a Molecule:** Two or more atoms chemically bonded together.

- **Types of Molecules:**
 - **Diatomic Molecules:** Consist of two atoms (e.g., O₂, H₂).
 - **Triatomic Molecules:** Consist of three atoms (e.g., CO₂).
 - **Polyatomic Molecules:** Consist of more than three atoms (e.g., P₄, S₈).

Element

- **Definition of an Element:** A substance that cannot be broken down into simpler substances by chemical means. Each element is defined by the number of protons in its atoms (atomic number).
- **Classification of Elements:**
 - **Metals:** Good conductors of heat and electricity, malleable, ductile, and have a shiny appearance (e.g., iron, gold, silver).
 - **Non-Metals:** Poor conductors of heat and electricity, brittle, and lack metallic luster (e.g., oxygen, carbon, sulfur).
 - **Metalloids:** Have properties intermediate between metals and non-metals (e.g., silicon, boron).

Compound

- **Definition of a Compound:** A substance formed when two or more different elements combine chemically in a fixed ratio.
- **Types of Compounds:**
 - **Ionic Compounds:** Formed by the transfer of electrons from one atom to another, resulting in oppositely charged ions that attract each other (e.g., NaCl).
 - **Covalent Compounds:** Formed by the sharing of electrons between atoms (e.g., H₂O, CO₂).
 - **Metallic Compounds:** Formed by metal atoms sharing a "sea" of electrons that are free to move around, providing metallic properties (e.g., alloys like steel).

Differences between Mixtures and Compounds

- **Mixtures:**
 - Consist of two or more substances physically combined.
 - Components retain their individual properties.
 - Composition can vary.
 - Can be separated by physical methods (e.g., filtration, distillation).
- **Compounds:**
 - Consist of two or more elements chemically combined.
 - Have different properties from their component elements.
 - Have a fixed composition.
 - Can be separated only by chemical methods (e.g., electrolysis).

These lecture notes cover the fundamental concepts related to Dalton's Atomic Theory and the basic definitions and classifications in chemistry. They provide a solid foundation for understanding the nature of matter and the distinctions between atoms, molecules, elements, and compounds.