Chapter 14

1. Introduction to Classification of Elements

- **Elements** are pure substances consisting of only one type of atom.
- As the number of known elements increased (now over 118), it became necessary to **classify them** to study their properties efficiently.

2. Why Are Elements Classified?

- To group elements with **similar properties** together.
- To predict the **properties of unknown elements**.
- To make the study of chemical behavior and reactions **systematic and easier**.
- To understand the **periodic trends** like atomic size, valency, reactivity, etc.

3. Periodic Table

- A **periodic table** is a systematic arrangement of elements in rows and columns based on their **atomic number**, **electronic configuration**, and **chemical properties**.
- The modern periodic table is the most widely accepted format.

4. Mendeleev's Periodic Table

- Introduced by Dmitri Mendeleev in 1869.
- Arranged elements in order of **increasing atomic mass**.
- Elements with similar properties were placed in **vertical columns (groups)**.

Salient Features of Mendeleev's Table:

- Consisted of **63 elements**.
- Left **gaps for undiscovered elements** (like Gallium, Scandium).
- Correctly predicted properties of **unknown elements**.
- Placed elements with similar properties in the **same group**.

Demerits of Mendeleev's Table:

- The **position of isotopes** was not clear.
- **Hydrogen** did not fit well in any group.
- **Inconsistencies** in placing elements strictly based on atomic mass (e.g., Ar before K).
- No separate place for **lanthanides and actinides**.
- The properties of **transition elements** were not clearly distinguished.

5. Modern Periodic Table

- Developed after Mendeleev and based on **atomic number** instead of atomic mass.
- Introduced by Henry Moseley in 1913.
- Also known as the **Long Form Periodic Table**.

6. Correction of Defects by Modern Periodic Table

a. Atomic Number:

- Atomic number (number of protons) is used as the basis for arrangement—resolves irregularities of atomic mass.

b. Position of Hydrogen:

- Can be placed in **Group 1** (like alkali metals) or **Group 17** (like halogens), depending on context.

c. Noble Gases:

- A separate **Group 18** is provided for noble gases (Helium, Neon, etc.).

d. Transition Metals:

- Properly placed in the **middle of the table** (Groups 3–12).

e. Lanthanides and Actinides:

- Placed in two **separate rows at the bottom** of the table.

f. Isotopes:

- All isotopes have the same atomic number and thus occupy **one position** in the table.

g. Periodic Law Correction:

- Modern Periodic Law: *"The properties of elements are the periodic function of their atomic numbers."*

h. Alkali and Coinage Metals:

- **Alkali metals** (Li, Na, K, etc.) placed in **Group 1**.
- **Coinage metals** (Cu, Ag, Au) placed in **Group 11**, with distinct properties.

7. Periods in the Modern Periodic Table

- **Periods** are **horizontal rows** in the periodic table.
- There are **7 periods**.
- Period number indicates the **number of shells** in the atom of the element.

Examples:

- 1st period: H, He (1 shell)
- 2nd period: Li to Ne (2 shells)

8. Groups in the Modern Periodic Table

- **Groups** are **vertical columns** in the periodic table.
- There are **18 groups**.
- Group number indicates the number of **valence electrons** (in representative elements).
- Elements in the same group have **similar chemical properties**.

9. Sub-Shells (Brief Overview)

- Sub-shells are parts of electron shells.
- Named as **s, p, d, f**.
- These determine the **electronic configuration** and **block position** of elements.

Capacity of sub-shells:

- s: 2 electrons
- p: 6 electrons
- d: 10 electrons
- f: 14 electrons

10. Aufbau Principle

- States that **electrons fill atomic orbitals in order of increasing energy**.
- Order: 1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p...

11. Blocks in the Modern Periodic Table

Based on which sub-shell is being filled with electrons.

Block	Sub-shell	Group Range	Type of Elements
s	s	1 and 2	Alkali and alkaline earth metals
p	p	13 to 18	Nonmetals, metalloids, noble gases
d	d	3 to 12	Transition metals
f	f	Lanthanides and Actinides	Inner transition metals

12. Properties of Periods and Groups

Across a Period (left to right):

- **Atomic size** decreases
- **Electronegativity** increases
- **Ionization energy** increases
- **Metallic character** decreases
- **Non-metallic character** increases

Down a Group:

- **Atomic size** increases
- **Electronegativity** decreases
- **Ionization energy** decreases
- **Metallic character** increases
- **Non-metallic character** decreases

13. Chemical Reactivity of Elements

- **Metals**: Lose electrons easily (more reactive down the group).
- **Non-metals**: Gain electrons (more reactive up the group).
- **Noble gases**: Chemically inert due to full valence shells.