CHAPTER 1
PERIODIC CLASSIFICATION OF ELEMENTS

NOTES

Robert Boyle defined an element as "any substance that cannot be decomposed into simpler substance by a chemical reaction".

Classification is grouping together of elements with similar properties and separating them from dissimilar ones. Classification makes the study of a larger number of elements and their properties easier.

1. Lavoisier's Classification (1789)

Easiest attempt in which elements on the basis of their properties is grouped as metals and non-metals. Limitation of Lavoisier's classification is that it was too broad and inadequate.

2. Dobereiner's Triad (1829)

When elements are arranged in order of increasing atomic mass, groups of three elements having similar chemical properties are obtained.

A Triad is a group of three elements having similar properties in which the atomic mass of the middle element is the arithmetic mean of the other two elements.

For example:

Atomic Mass(u)	Element
40.1	Ca
87.6	Sr
137.3	Ba

Here,

Average of the atomic masses of Ca& Ba

$= \frac{40.1+137.3}{2} = \frac{177.4}{2} =$ 88.7 which is approximately equal to 87.6, the atomic mass of Sr.

Hence, the groups of these three elements, Ca, Sr, Ba forms a Doberiener's triad.

Limitation of Dobereiner's Triad: All known elements could not be put in form of triads.

3. Newlands' Law of Octaves(1866)

When elements are arranged according to increasing atomic masses, the physical and chemical properties of every eighth element are similar to that of the first.

Newlands compared this to the octaves found in the eight notes of a musical scale. He called it the "Law of octaves".

Limitations

1. The law was applicable for elements with atomic masses up to 40.
2. Properties of new elements discovered later did not fit into the law of octaves.

4. Mendeleev's Classification

Dmitri Mendeleev developed the Mendeleev's periodic table with the Mendeleev's periodic law as the basic principle. Mendeleev's periodic law states that, ***"the physical and chemical properties of elements are periodic functions of their atomic masses"***.

It is the most successful classification on all the earlier attempts at classification based on atomic mass of elements.

Features of Mendeleev's Periodic Table

- Six horizontal rowsknown as periods.
- Eight vertical columns known as groups.
- Groups I to VII subdivided into subgroups A and B.
- Elements which lie on left hand side of each group constitute sub-group A and are called normal or representative elements.
- Elements which lie on right hand side of each group constitute sub-group B and are called transition elements.
- Group VIII doesn't have any subgroups and contain three elements in each row.
- Elements in the same group exhibit similar properties.

Achievements of Mendeleev's Periodic Table

1. Elements with similar properties are grouped together.
2. Placement of elements helped in correcting the atomic masses of certain elements. E.g. the atomic mass of Beryllium was corrected from 13.65 to 9.
3. Eka-boron, Eka-aluminium and Eka-silicon were the names given to yet to be discovered elements. These elements, when discovered were named as Scandium, Gallium, and Germanium respectively.
4. **Noble gases,** when discovered, were placed easily in a new group called Zero Group, without disturbing the existing order.

Limitations of Mendeleev's Periodic Table

1. No fixed position of Hydrogen.
2. No position for isotopes of elements.
3. No regular trend in atomic mass.
4. There is defect regarding grouping of elements.

5. Modern periodic table-Henry Mosely (1913)

The basis for the classification of elements is the atomic number. Modern periodic law states that, ***"the properties of elements are the periodic function of their atomic numbers".***

Features of Modern Periodic Table

The modern periodic table has 7 horizontal rows called ***'periods'*** and 18 vertical columns called ***'groups'*** or families.

Periods in Modern Periodic Table

Elements present in the same period have the same number of shells which is equal to the period number.

On moving from left to right in a given period, the number of electrons in the valence shell increases from one to eight while the number of shells remains the same.

Number of Elements in a Period

- 1^{st}period contains only two elements H(1) and He(2) and is known very short.
- 2^{nd}period [Li(3) to Ne(10)]and 3^{rd} period [Na(11)to Ar(18)]contain 8 elements each and are known as short periods.
- 4^{th} period [K(19) to Kr(36)]and 5^{th} period [Rb(37) to Xe(54)] contain 18 elements each and are called long periods.
- 6^{th}period contains 32 elements [Cs(55) and Ru(86) and is also known very long period.
- 7^{th}period an incomplete period.
- Two series of elements, 14 each are placed at the bottom of the main body of the periodic table constitute the Lanthanide series and actinide series.

Groups in Modern Periodic Table

- 18 vertical columns known as groups.
- Group 1,2 and 13-18 (normal representation elements)
- Group 1 elements are known as alkali metals.
- Group 2 elements are known as alkaline earth metals.
- Group 3-12 (transition elements)
- Group 17 elements are known as halogens.
- Group 18 elements are known as noble gases.

Alkali Metals

- Elements in the first group are Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Caesium (Cs), and Francium (Fr)
- Number of valence electrons = 1

Alkaline Earth Metals

- Elements in the second group are Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba), and Radium (Ra)
- Their oxides are alkaline in nature.
- Number of valence electrons = 2

Halogens

- Elements in the 17thgroup are Fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At).
- Number of valence electrons = 7

Noble Gases

- Elements in the18thgroup, Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and he radioactive Radon (Rn).
- Odourless, colourless and monatomic gases with very low chemical reactivity.
- Number of valence electrons = 8

Position of Elements in the Periodic Table

- It is determined from the electronic configuration of elements.
- Group corresponds to the number of valence electrons
  - i) If number of valence electron is either 1 or 2, group number = 1 or 2
  - ii) If number of valence electron is more than 2, group number = 10 + number of valence electrons.

Classification of elements in the Modern Periodic Table

1. Metals
2. Non-metals and
3. Metalloids.

1. Metals
- Electropositive as they are formed by losing electron(s).
- Oxides of metals are basic in nature.
- Examples: Sodium, Potassium, Calcium, Gold, Silver etc.

2. Non-metals
- Electronegative as they are formed by gaining electron(s).
- Oxides of non-metals are acidic in nature.
- Examples: Carbon, Sulphur, Iodine, Oxygen, Nitrogen etc.

3. **Metalloids**
   - Elements which show the properties of both metals and non-metals
   - Examples – Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium, and Polonium.

Trends in Periodic Properties in Modern Periodic Table

Valence Electron(s): number of electrons present in the outermost valence shell of an atom.

In a group – elements have the same number of valence electrons.

Along a period – valence shell electrons increases by one unit.

Valency

Valency is the combining capacity of an atom of an element. It can be determined by number of valence electrons present in the outermost shells.

All the elements of a group have the same number of valence electrons. Therefore, they all have the same valency.

On moving from left to right in each of the short periods, the valency of elements increases from 1 to 4and then decreases to 0.

Atomic Size

Atomic size or radii defined as the distance from the centre of the nucleus to the valence shell of the atom.

Along a period – Atomic radius decreases because effective nuclear charge increases by one unit and it pulls valence electrons or the electron cloud closer to the nucleus.

Down the group – Atomic radius increases because new shells are added, hence, the distance between the nucleus and valence electrons or the electron cloud increases.

Metallic Properties (Electropositive character)

Along a period – Metallic character decreases because the tendency to lose valence electrons decreases due to increasing nuclear charge.

Down the group- As the distance between the nucleus and outermost electron increases, nuclear pull decreases. This increases the tendency of an atom to lose valence electron, hence metallic character increases.

Non-metallic Properties (Electronegative character)

Along a period – Non-metallic character increases as the tendency to gain electrons in the valence shell increases due to increasing nuclear charge.

Down the group – As the distance between the nucleus and valence shell increases, nuclear pull decreases. This decreases the tendency of an atom to gain an electron in its valence shell. Hence, non-metallic character decreases.

Nature of Oxides

Along a period- Basic nature of the oxides gradually decreases and acidic nature of the oxides gradually increases.

Down the group - Basic character of oxides increases and acidic character of oxides decreases.

Example: Nature of oxides of third period elements

Elements Of 3rd period	Na	Mg	Al	Si	P	S	Cl	Ar
Oxides	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_2,SO_3	Cl_2O_7	
Nature	Strongly basic	Basic	Amphoteric	Amphoteric	Acidic	Acidic	Highly acidic	