Periodic Classification of Elements

Need for Classification: It is difficult to study each and every element individually and to know its properties and uses. Therefore, they have been classified into groups on the basis of their similarities in properties. In 1803, Dalton published a table of relative atomic weights (now called atomic masses) which formed important basis of classification at that time.

Dobereiner's Triads In the year 1829, Johann Wolfgang Dobereiner, a German scientist, was the first to classify elements into groups based on John Dalton's assertions. He grouped the elements with similar chemical properties into clusters of three called 'Triads'. The distinctive feature of a triad was the atomic mass of the middle element. When elements were arranged in order of their increasing atomic mass, the atomic mass of the middle element was approximately the arithmetic mean of the other two elements of the triad.

Defects of Triad Classification

- A large number of similar elements could not be grouped into triads e.g., iron, manganese, nickel, cobalt, zinc and copper are similar elements but could not be placed in the triads.
- It was possible that quite dissimilar elements could be grouped into triads.
- Dobereiner could only classify 3 triads successfully (highlighted in the table).

Newlands' Law of Octaves Newland stated his law of octaves thus 'when elements are arranged in increasing order of their atomic mass, the eighth element resembles the first in physical and chemical properties just like the eighth note on a musical scale resembles the first note'. As a result a very important conclusion was made that there is some systematic relationship between the order of atomic masses and the repetition of properties of elements. This gave rise to a new term called 'periodicity' which signifies the recurrence of characteristic properties of elements arranged in a table, at regular intervals of a period.

Achievements of the Law of Octaves

- The law of octaves was the first logical attempt to classify elements on the basis of atomic weights.
- Periodicity of elements was recognized for the first time.

Defects of Law of Octaves

- This law could be best applied, only up to the element calcium.
- Newly discovered elements could not fit into the octave structure. The feature of resemblance of the 8th element when arranged in increasing order of their atomic mass was not successful with heavier elements.

Mendeleev's Periodic Table Mendeleev arranged 63 elements known at that time on the basis of similarities in properties, *i.e.*, on the basis of similarities in the formulae of their oxides, hydrides, etc., formed by these elements. He observed that most of the elements were placed in the increasing order of their atomic masses.

He found that the elements with similar properties recur at regular intervals when the elements are arranged in the order of their increasing atomic masses. He concluded that 'the physical and chemical properties of the elements are periodic functions of their atomic masses'.

Achievement of Mendeleev's Classification

(i) He could classify all the 63 elements discovered at that time on the basis of similarities in properties

(ii) He left gaps for yet to be discovered elements.

(iii) He predicted the properties of undiscovered elements and thus helped in the discovery of these elements later on.

(iv) He named them by prefixing a Sanskrit numeral eka (one), divi (two), tri (three), etc. to the name of the preceding similar (analogous) element in the same group, *e.g.*, eka-boron, eka-aluminium, eka-silicon, eka-manganese, divi-manganese and eka-tantalum.

(v) Mendeleev's periodic table helped in correcting the atomic masses of some of the elements, based on their positions in the periodic table. For example, atomic mass of beryllium was corrected from 13.5 to 9.0. Atomic masses of indium, gold and platinum were also corrected.

Limitations of Mendeleev's Classification

(i) Although most of the elements were placed in the order of increasing atomic masses, increasing order could not be maintained in all cases, *e.g.*, Cobalt (Atomic mass 58.93) preceded nickel (58.71); tellurium (127.6) preceded iodine (126.90) but he could maintain similarity in properties, *e.g.*, 'Te' resembles 'Se', 'I' resembles 'Br'.

(ii) Mendeleev's Periodic Table did not provide place for noble gases which were discovered later.

(iii) There was no place for isotopes in Mendeleev's Periodic Table, although they differ in atomic mass.

Modern Period Table Henry Moseley, an English physicist found that the atomic number (Z) was the fundamental property of an element and not the atomic mass for classification of elements.

Modern Periodic Law "Properties of elements are periodic functions of their atomic numbers, *i.e.*, the number of protons or electrons present in the neutral atom of an element."

Main Features of the Long Form of the Periodic Table

(i) It shows arrangement of elements based on modern periodic: law.
(ii) There are **18** vertical columns known as *groups*.
(iii) There are 7 horizontal rows known as *periods*.
(iv) Elements having similar outer electronic configurations, *i.e.*, having same valence electrons have been placed in same groups.

Elements in a Group

(i) They show similar chemical properties due to similar outer electronic configuration, *i.e.*, same number of valence electrons.
(ii) They have gradation in properties due to gradually varying attraction of the nucleus and the outer valence electrons as we go down the group.

Periods

(i) The horizontal rows in the periodic table are called periods.
(ii) There are 7·periods in the long form of periodic table.
(iii) The first period contains 2 elements, Hydrogen and Helium. They have only one shell.

Variation of Atomic size in a Group. Atomic size generally increases from top to bottom in a group.
Reason. It is due to addition of a new shell, *i.e.*, number of shells go on increasing

Variation of Atomic size along a Period. Atomic size goes on decreasing along a period from left to right.
Reason. It is due to increase in nuclear charge (number of protons in nucleus) which pulls the electrons towards it, *i.e.*,force of attraction between nucleus and valence electrons increases, therefore atomic size decreases.

Variation of Ionisation energy down a Group. Ionisation energy goes on decreasing down a group.
Reason: It is due to the increase in the distance between the valence electrons and the nucleus as the atomic size increases down a group, the force of attraction between the nucleus and the valence electrons decreases, therefore, the energy required to remove the electrons, *i.e.*, the ionisation energy goes on decreasing.

Variation of Ionisation energy along a Period. It goes on increasing generally along a period from left to right with decrease in atomic size.
Reason : Due to decrease in atomic size, the force of attraction between the valence electrons and the nucleus increases and, therefore, more energy is required to remove electron.

Variation down the Group. Electron affinity goes on decreasing down the group in general.
Reason. Due to the increase in atomic size, the force of attraction between the nucleus and the electron to be added becomes less.

Variation along a Period. Electron affinity increases from left to right in a period.
Reason. It is due to decrease in atomic size which leads to an increase in the force of attraction between the nucleus and the electron to be added.

Variation of Metallic Character. Metallic character increases down a group due to decrease in ionisation energy. It decreases along a period due to increase in ionisation energy from left to right.

Variation of Non-metallic Character. Non-metallic character decreases down a group because of decrease in electron affinity which is due to increase in atomic size. Along a period, non-metallic character inc-reases from left to right due to increase in electron affinity which is due to decrease in atomic size.