Introduction

- We all know that various thing or living things can be classified on the basis of their properties. Even in shops various items belonging to same category are kept together in groups. For example, soap are kept together at one place, biscuits are kept together elsewhere.
- Similarly, scientists made several attempts to classify elements according to their properties.

Döbereiner's Triads

- In the year 1817, a German chemist, Johann Wolfgang Döbereiner, arrange the elements with similar properties into groups.
- He arranged three elements in one group. So, he called these groups 'triads'.
- He could identify only three triads from the elements known at that time.
- On writing the three elements of the triad in the order of increasing atomic masses it was observed that the atomic mass of the middle element was almost equal to the average of the atomic masses of the other two elements.
- For example, take the triad consisting of lithium (Li), sodium (Na) and potassium (K) with the respective atomic masses 6.9, 23.0 and 39.0.
- This system was not found useful because only 3 triads could be formed and therefore most of the elements were not classified by this method.

Newlands' Law of Octaves

- In 1866, an English scientist, John Newlands, arranged the then known elements in the order of increasing atomic masses starting from Hydrogen having lowest atomic mass and ended at Thorium which was the 56^{th} element.
- He observed that every eighth element had properties similar to that of the first. Comparing with the octave of the music he called it the law of octaves or Newland's law of octaves.
- But the Law of Octaves was applicable only up to calcium, after which every eighth element did not resemble the first element.

Limitations of Newlands' Law of Octaves

- In order to fit elements into his Table, Newlands not only adjusted two elements in the same slot, but also arranged some unlike elements under the same
  note.
- Cobalt and Nickel are kept in the same slot and these are placed in the same

column as fluorine, chlorine and bromine which have very different properties than these elements.

- Newlands assumed by that only 56 elements existed in nature and no more elements would be discovered in the future. But, later on, several new elements were discovered, whose properties were not as per the Law of Octaves.
- Iron, which resembles cobalt and nickel in properties, was placed far away from these elements.

MENDELÉEV'S PERIODIC TABLE

- A Russian chemist Dmitri Ivanovic Mendeleev, was the most important contributor to the early development of a Periodic Table of elements. He arranged the elements on the basis of their atomic masses.
- In Mendeleev's periodic table, only 63 elements were arranged with reference to the relationship between the atomic masses of the elements and their physical and chemical properties
- Most of the elements got placed in the Periodic Table and could be arranged in the order of their increasing atomic masses.
- On this basis, Mendeleev formulated a Periodic Law, which states that 'the properties of elements are the periodic function of their atomic masses'.

Achievement of Mendeleev's periodic table

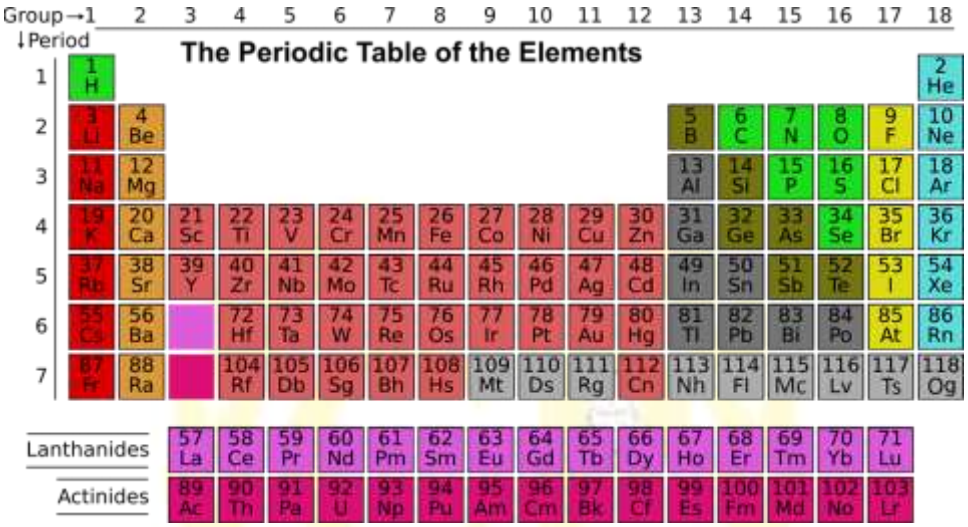
- Mendeléev placed an element with a slightly greater atomic mass before an element with a slightly lower atomic mass. This sequence was inverted so that elements with similar properties could be grouped together. For example, cobalt with atomic mass 58.9 is placed before nickel with atomic mass 58.7.
- Mendeléev left some gaps in the periodic table with the prediction of existence of new elements that were not discovered that time.
- He named them by prefixing a Sanskrit numeral ***eka*** to the name of preceding element in the same group.
- For example, scandium, gallium and germanium, which were discovered later, have properties similar to Eka–boron, Eka–aluminium and Eka–silicon, respectively.
- Noble gases like helium (He), neon (Ne) and argon (Ar) were discovered very late because they are very inert in nature and present in extremely low concentrations in the atmosphere.

Limitations of Mendeléev's Classification

- No fixed position could be given to hydrogen in the Periodic Table.
- The isotopes were discovered long after his periodic classification of elements. These posed a challenge to Mendeleev's Periodic Law.
- The atomic masses did not increase in a regular manner in going from one element to the next. This made it difficult to predict how many elements could be discovered between two elements.

Modern Periodic table

- In 1913, Henry Moseley proved that the atomic number of an element is a more fundamental property than its atomic mass.
- Mendeléev's Periodic Law was modified and atomic number was taken as the basis of Modern Periodic Table.
- The Modern Periodic Law can be stated as follows:
  'Properties of elements are a periodic function of their atomic number.'
- The atomic number is the number of protons in the nucleus of an atom and this number increases by one in on moving from one element to the next.



Position of Elements in the Modern Periodic Table

- The Modern Periodic Table comprises of 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'.
- The elements present in any one group have the same number of valence electrons. For example, elements fluorine (F) and chlorine (Cl), belong to group 17, both have 7 electrons in the valence shell.
- Hydrogen can be placed either in group 1 or group 17 in the first period.
- The maximum number of electrons that can be filled in a shell depends on the formula $2n^2$ where 'n' is the number of the given shell from the nucleus.
- For example,

  K Shell – $2 \times (1)^2 = 2$, thus the first period has 2 elements.

  L Shell – $2 \times (2)^2 = 8$, thus the second period has 8 elements.

  The third, fourth, fifth, sixth and seventh periods have 8, 18, 18, 32 and 32 elements respectively.
- Metals like Na and Mg occupy the left-hand side whereas the non-metals like sulphur and chlorine occupy the right-hand side of the Periodic Table. Silicon

or some metals that exhibit the properties of both metals and non-metals known as semi-metal or metalloid are placed in the middle of the periodic table.

Trends in the Modern Periodic Table

- **Valency –** The valency of an element is basically the number of valence electrons present in the outermost shell of its atom.
- **Atomic size** -The term atomic size refers to the radius of an atom. The atomic size may be defined as the distance between the centre of the nucleus and the outermost shell of an isolated atom. The atomic radius of hydrogen atom is 37 pm (picometre, 1 pm = 10^{-12} m).
- The atomic size increases down the group. This is because new shells are being added as we go down the group.
- This increases the distance between the outermost electrons and the nucleus so that the atomic size increases in spite of the increase in nuclear charge.
- Atomic size decreases in moving from left to right along a period due to an increase in nuclear charge pulling the electrons closer to the nucleus.
- **Metallic and non- metallic properties -**On moving across a period effective nuclear charge acting on the valence shell electrons increases because of which the tendency to lose electrons decreases. Hence metallic character decreases and non-metallic character increases across a period.
- On moving down the group, the effective nuclear charge decreases because of which the tendency to lose electrons increases. Hence, the metallic character increases and non-metallic character decreases down the group.