CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

WHY DO WE NEED TO CLASSIFY ELEMENTS?

OBJECT AND NEED OF CLASSIFICATION OF ELEMENTS

Elements are the basic constituents of all types of matter. The discovery of chemical elements has been an ongoing process since ancient times. Certain elements, such as gold, appear in nature in elemental form and were thus discovered thousands of years ago. In contrast, some elements are radioactive and intrinsically unstable. The majority of the elements although stable are dispersed widely in nature and incorporated into numerous compounds. For centuries, therefore, scientists were unaware of their existence. At the beginning of the eighteenth century, only a few elements were known. During eighteenth and early nineteenth century, advances in chemistry made it easier to isolate elements from their compounds. As a result, the number of known elements had more than doubled from 31 in 1800 to 63 by 1865. At present, 117 elements* are known. Out of these, recently discovered elements are not natural but synthetic, i.e., man-made and efforts are still going on to synthesize new elements by artificial transmutation. As the number of known elements increased, it became rather impossible to study individually the chemistry of these elements and their innumerable compounds and scientists began to investigate the possibilities of classifying them in useful ways. The basic object and need of classification can be best stated in the words of Huxley, “The actual or ideal arrangement together of those which are alike and separation of those which are unlike; the purpose of this arrangement being primarily to disclose the correlations, or laws of union, or properties, or circumstances and secondarily to facilitate the operation of the mind in dearly receiving and then retaining in the memory the characteristics of the objects in question." In short, it can be stated that the basic object of classification is to arrange the facts regarding elements and their compounds in such a way so that we may have greatest control over their characteristics with least possible effort. The best classification would be one which puts together those elements which resemble in most respects and separates other. Attempts were made to classify the elements according to one property or the other. The elements were classified into metals and nonmetals; into electropositive and electronegative. They were classed according to their valency as monovalent, divalent, trivalent, etc. In these classifications, the same element frequently appeared in more than one class and hence all these early classifications were considered as rough classifications. After the establishment of Dalton's atomic theory, the chemists took atomic mass as the fundamental property of the element and tried to seek a relationship between the properties of the elements and their

atomic masses. A number of classifications, taking atomic masses of the elements as the basis, were presented. The best formulation resulted in the form of periodic table in which elements have been arranged according to their properties in a tabular form. The elements belonging to same vertical column constitute a chemical family having similar properties. The arrangement of elements in order of increasing atomic masses, with elements having similar properties in vertical columns, is known as periodic table. The periodic classification (long or extended form of periodic table) of elements has extremely simplified the study of such a large number of elements.

DEVELOPMENT OF PERIODIC TABLE

1. PROUT'S HYPOTHESIS

He simply assumed that all the elements are made up of hydrogen, so we can say that

Atomic weight of element = n × (Atomic weight of one hydrogen atom)

Atomic weight of H = 1

where n = number of hydrogen atom = 1, 2, 3,....

Drawback or Limitation

(a) Every element cannot be formed by Hydrogen.

(b) The atomic weights of all elements were not found as whole numbers.

Ex. Chlorine (atomic weight 35.5) and Strontium (atomic weight 87.5)

2. DOBEREINER TRIAD RULE

J.W. Dobereiner's pointed out that within a group of three elements having similar chemical and physical properties, the atomic weight of the middle element is the mean of the other two. Some examples of such triads are given below. He also pointed out the triad - iron, cobalt and nickel in which the atomic weights of the elements are almost the same.

Some representative triads of Dobereiner's

DÖBEREINER'S TRIADS

Triads			Mean of atomic masses of 1st and 3rd elements
Li	Na	k	$\frac{7+39}{2}=23$
7	23	39	
Cl	Br	I	$\frac{35.5+127}{2}=81.25$
35.5	80	127	

Ca	Sr	Ba	$\frac{40+137}{2}=88.5$
40	88	137	
S	Se	Te	$\frac{32+127}{2}=79.5$
32	79	127	
P	As	Sb	$\frac{31+120}{2}=75.5$
31	75	120	
Fe	Co	Ni	Nearly same atomic masses
Ru	Rh	Pd	Nearly same atomic masses
Os	Ir	Pt	Nearly same atomic masses

Triad	Li	Na	K	Ca	Sr	Ba	S	Se	Te	Cl	Br	I
Elements												
Atomic weight	7	23	39	40	88	137	32	80	128	35.5	80	127
Mean value		23			88.5			80			81.25	

Other Ex. (K, Rb, Cs), (P, As, Sb) (H, F, Cl) (Sc, Y, La).

Though it was the first successful attempt to rationalise the problem, it could not be generalised or extended.

Drawback or Limitation: All the known elements could not be arranged as triads.

NEWLAND'S OCTET LAW

John Alexander Reina new land in England made the first attempt to correlate the chemical properties of the elements with their atomic weight. According to him -

(a) If the elements are arranged in order to their increasing atomic weights, every eighth element had similar properties to first one like the first and eighth note in music. For example

Sa	Re	Ga	Ma	Pa	Dha	Ni	Sa
Li	Be	B	C	N	O	F	Na
Na	Mg	Al	Si	P	S	Cl	K

(b) Inert gases were not discovered till then.

(c) All the elements could not be classified on this basis.

4. LOTHER MEYER'S CURVE

(a) He plotted a curve between atomic weight and atomic volume of different elements.

(b) The following observation can be made from the curve –

(I) Most electropositive elements i.e. alkali metals (Li, Na, K, Rb, Cs etc.) occupy the peak positions on the curve.

(II) Less electropositive i.e. alkali earth metal (Be, Mg, Ca, Sr, Ba) occupy the descending position on the curve.

(III) Metalloids (B, Si, As, Te, At etc.) and transition metals occupy bottom part of the curve.

(IV) Most electronegative i.e. halogens (F, Cl, Br, I) occupy the ascending position on the curve.

Note : Elements having similar properties occupy similar position on the curve.

Conclusion : On the basis of this curve Lother Meyer proposed that the physical properties of the elements are

periodic function of their atomic wt. and this become the base of Mendeleef's periodic table.