Periodic Classification of Elements Mendeleev's Periodic Table

*** MENDELEEV'S PERIODIC TABLE (1869):**

Mendeleev's Periodic Table was published in a German journal in 1872. In the formula for oxides and hydrides at the top of the columns, the letter R is used to represent any of the elements in the group. Note the way formulae are written. For example, the hydride of carbon, CH_4 is written as RH_4 and the oxide CO_2 as RO_2 .

Group	Ι	II	Ш	IV	V	VI	VII	VIII
Oxide Hydride	R ₂ O RH	RO RH ₂	R ₂ O ₃ RH ₃	RO ₂ RH ₄	R ₂ O ₅ RH ₃	RO ₃ RH ₂	R ₂ O ₇ RH	RO ₄
$\stackrel{\text{Periods}}{\downarrow}$	A B	A B	A B	A B	A B	A B	A B	Transition Series
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	0 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453	
4 First series	K 39.102	Ca 40.08	Sc 44.96	Ti 47.90	V 50.94	Cr 50.20	Mn 54.94	Fe Co Ni 55.85 58.93 58.71
Second series	Cu 63.54	Zn 65.37	Ga 69.72	Ge 72.59	As 74.92	Se 78.96	Br 79.909	
5 First series	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 99	RuCoNi101.07102.91106.4
Second series	Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	
6 First series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.85		Os Ir Pt 190.2 192.2 195.09
Second series	Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98			

(i) **Mendeleev's Periodic Law** : The physical and chemical properties of elements are the periodic function of their atomic weight.

(ii) Characteristic of Mendeleev's periodic table.

- (a) It was based on atomic weight.
- (b) 63 elements were known at that time.
- (c) Noble gases were not discovered.
- (d) He was the first scientist to classify the elements in a systematic manner i.e. in horizontal rows and in vertical columns.

- (e) Horizontal rows are called periods and there were 7 periods in Mendeleev's periodic table.
- (f) Vertical columns are called groups and there were 8 groups in Mendeleev's Periodic table.
- (g) Each group upto VII is divided into A & B subgroups, 'A' sub groups elements are called normal elements and 'B' subgroups elements are called transition elements.
- (h) The VIII group contains 9 elements in three rows (Transitional metals group)
- (i) The elements belonging to same group exhibit similar properties.

Achievements of Mendeleev's Periodic Table

(i) Predication of undiscovered element : Further, Mendeleev left some gaps in his Periodic Table. Instead of looking upon these gaps as defects, Mendeleev predicted the existence of some elements that had not been discovered at that time. Mendeleev named them by prefixing a Sanskrit numeral, Eka (one) to the name of preceding element in the same group.

For instance, scandium, gallium and germanium, discovered later, have properties similar to B, Al, Si that's why they were termed as Eka-boron, Eka-aluminium and Eka-silicon respectively. The properties of Eka-aluminium predicted by Mendeleev and those of the element, gallium which was discovered later and replaced Eka-aluminium are listed as follows

Table: Properties of Eka-aluminium and gallium

- (ii) Classification of elements : This provided convincing evidence for both the correctness and usefulness of Mendeleev's Periodic Table. Further, it was the extraordinary success of Mendeleev's prediction that led chemists not only to accept his Periodic Table but also recognise him, as the originator of the concept on which it based. Mendeleev's periodic table could perdict the properties of several elements on the basis of their position in the periodic table.
- (iii) Correction of doubtful atomic weights of some elements : Initially Berilium assumed as trivalent and equivalent weight = 4.5

Chemistry

Atomic Weight = Valency × equivalent weight = 3×4.5 = 13.5

But there is no space for such element then correction has been done and Berilium assumed as divalent.

Atomic Weight = Valency × equivalent weight = 2×4.5 = 9

Other example, Atomic weight correction are U, Be, Ln, Au, Pt.

Limitations of Mendeleev's Classification

1. Anomalous pairs of elements : While developing the Periodic Table, there were a few instances where Mendeleev had to place an element with a slightly greater atomic mass before an element with a slightly lower atomic mass. The sequence was inverted so that elements with similar properties could be grouped together. For example, cobalt (atomic mass 58.9) appeared before nickel (atomic mass 58.7).

2. **Position of Hydrogen :** Electronic configuration of **hydrogen** resembles that of **alkali metals**. Like alkali metals, hydrogen combines with halogens, oxygen and sulphur to form compounds having similar formulae.

On the other hand, just like halogens, hydrogen also exists as diatomic molecules and it combines with metals and non-metals to form covalent compounds.

3. **Position of Isotopes:** Isotopes of elements were placed in the same position in the table though according to their atomic weights, they should have been placed in different position.

4. **Separation of similar but grouping of certain dissimilar elements:** Certain chemically similar elements like copper and mercury were placed in different group while some other dissimilar elements like copper, silver and gold have been placed in the same group. **5. Noble gases** like helium (He), neon (Ne) and argon (Ar) have been discovered later because they are very inert and present in extremely low concentrations in our atmosphere. One of the strengths of Mendeleev's Periodic Table was that, when these gases were discovered, they could be placed in a new group without disturbing the existing order.

6. **Lanthanides and Actinides:** A group of 14 elements (at No. 58 to 71) called rare earths metal or lanthanide were placed together in one position i.e. in group III B of 6th period. Similarly another group of elements called actinides do not find their proper places in this periodic table.

Illustration 5

Many scientists before Mendeleev also used atomic mass as the basis of classification, but why did only Mendeleev succeed.

Solution

The secret of Mendeleev's success was that although the classification was based on atomic mass, but at many places he did not follow this rule rigidly. He laid major stress on the similarity in the chemical and physical properties.

Illustration 6

Why did Mendeleev leave many gaps in his periodic table?

Solution

Mendeleev predicted that there were many elements yet to be discovered. So, when none of the elements known at that time fit into a particular position, he left a gap there. Later, when more elements were discovered these were found to fit into these gaps.