Periodic Classification of Elements

At present, 118 elements are known to us. All these have different properties. Out of these 118, only 94 are naturally occurring.

Dobereiner's Triads – He identified some groups having three elements each. So he called these groups 'triads'. Dobereiner showed that when the three elements in a triad were written in the order of increasing atomic masses; the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements. Eg:-

Group A element	Atomic mass	Group B element	Atomic mass	Group C elements	Atomic mass
N	14.0	Ca	40.1	Cl	35. 5
P	31.0	Sr	87.6	Br	79.9
As	74.9	Ba	137.3	I	126.9

Dobereiner could identify only three triads from the elements known at the time.

Newlands' Law of Octaves – In 1866, John Newlands, an English scientist, arranged the then known elements in the order of increasing atomic masses. He found that every eighth element had properties similar to that of the first. He compared this to the octaves found in music. Therefore, he called it the 'Law of Octaves'. It is known as 'Newlands' Law of Octaves'

Newlands' Octaves

Notes of Music:

sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	—	—

It was found that the Law of Octaves was applicable only upto calcium, as after calcium every eighth element did not possess properties similar to that of the first.

Newlands' Law of Octaves worked well with lighter elements only.

Mendeleev's Periodic Table – The main credit for classifying elements goes to Dmitri Ivanovich Mendeleev, a Russian chemist. He was the most important contributor to the early development of a Periodic Table of elements wherein the elements were arranged on the basis of their fundamental property, the atomic mass, and also on the similarly of chemical properties.

He examined the relationship between the atomic masses of the elements and their physical and chemical properties.

Mendeleev formulated a Periodic Law, which states that 'the properties of elements are the periodic function of their atomic masses'.

Mendeleev's Periodic Table contains vertical columns called 'groups' and horizontal rows called 'periods'.

Mendeleev's Periodic Table

Groups	I	II	III	IV	V	VI	VII	VIII
Oxides Hydrides	RO RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
Periods ↓	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	O 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: Second series:	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 50.20 Se 78.96	Mn 54.94 Br 79.909	Fe 55.85 Co 58.93 Ni 58.71
5 First series: Second series:	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.82	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Tc 99 I 126.90	Ru 101.07 Rh 102.91 Pd 106.4
6 First series: Second series:	Cs 132.90 Au 196.97	Ba 137.34 Hg 200.59	La 138.91 Tl 204.37	Hf 178.49 Pb 207.19	Ta 180.95 Bi 208.98	W 183.85		Os 190.2 Ir 192.2 Pt 195.09

Limitations of Mendeleev's Classification

No fixed position can be given to hydrogen in the Periodic Table. This was the first limitation of Mendeleev's Periodic Table. He could not assign a correct position to hydrogen in his Table.

Isotopes were discovered long after Mendeleev had proposed his periodic classification of elements.

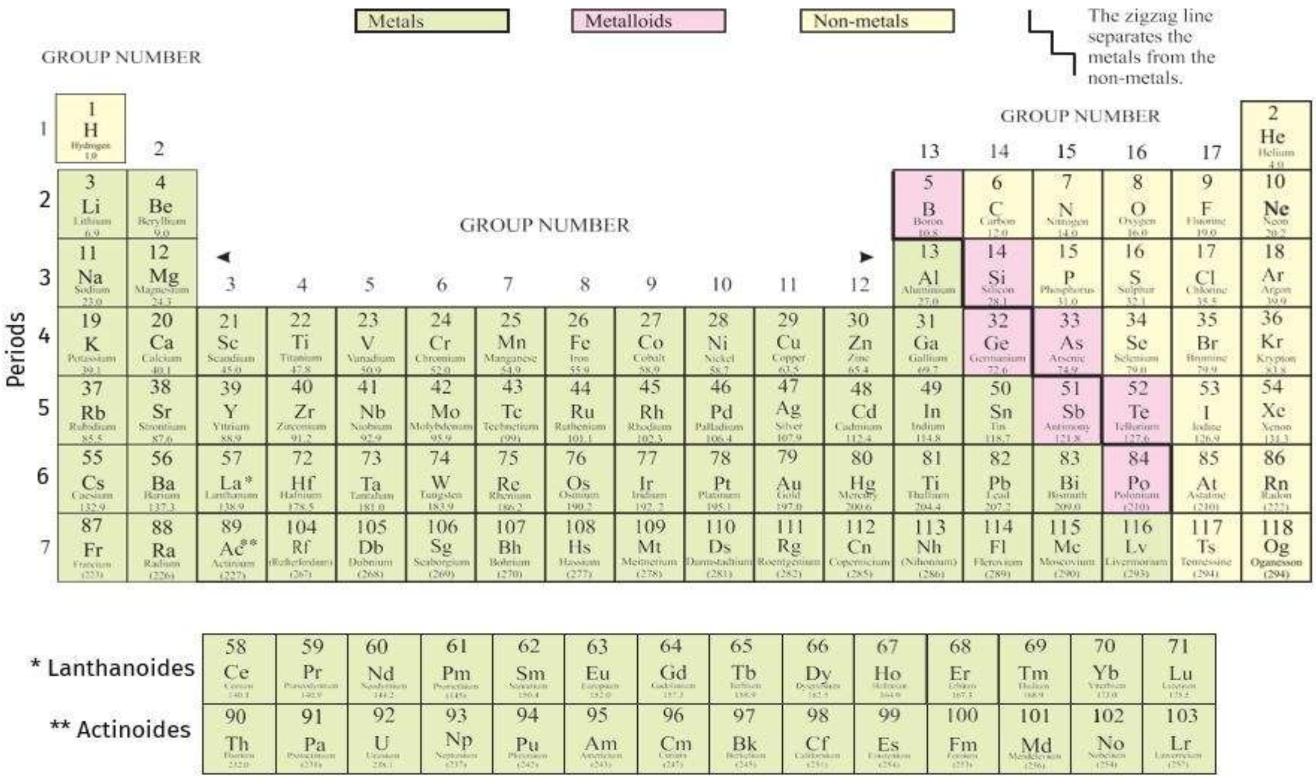
Thus, isotopes of all elements posed a challenge to Mendeleev's Periodic Law. Another problem was that the atomic masses do not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements – especially when we consider the heavier elements.

The Modern Periodic Table

In 1913, Henry Moseley showed that the atomic number (symbolized as Z) of an element is a more fundamental property than its atomic mass.

'Properties of elements are a periodic function of their atomic number.'

Modern Periodic Table



The Modern Periodic Table takes care of three limitations of Mendeleev's Periodic Table.

Position of Elements in the Modern Periodic Table

The Modern Periodic Table has 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'.

- Look at the group 1 of the Modern Periodic Table, and name the elements present in it.
- Write down the electronic configuration of the first three elements of group 1.
- What similarity do you find in their electronic configurations?
- How many valence electrons are present in these three elements?

All these elements contain the same number of valence electrons. Similarly, you will find that the elements present in any one group have the same number of valence electrons.

- If you look at the Modern Periodic Table. You will find that the elements Li, Be, B, C, N, O, F, and Ne are present in the second period. Write down their electronic configurations.
- Do these elements also contain the same number of valence electrons?
- Do they contain the same number of shells?

These elements of second period do not have the same number of valence electrons, but they contain the same number of shells. The number of valence shell electrons increases by one unit, as the atomic number increases by one unit on moving from left to right in a period.

Trends in the Modern Periodic Table

Valency: the valency of an element is determined by 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 visualized as the distance between the centre of the nucleus and the outermost shell of an isolated atom.

The atomic radius decreases in moving from left to right along a period. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

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.

Metallic and Non-metallic Properties

The metals like Na and Mg are towards the left-hand side of the Periodic Table while the non-metals like sulphur and chlorine are found on the right-hand side. In the middle, we have silicon, which is classified as a semi-metal or metalloid because it exhibits some properties of both metals and non-metals.

The borderline elements – boron, silicon, germanium, arsenic, antimony, tellurium and polonium – are intermediate in properties and are called metalloids or semi-metals.

Metals tend to lose electrons while forming bonds, that is, they are electropositive in nature.

The effective nuclear charge acting on the valence shell electrons increases across a period, the tendency to lose electrons will decrease. Down the group, the effective nuclear charge experienced by valence electrons is decreasing because the outermost electrons are farther away from the nucleus. Therefore, these can be lost easily. Hence metallic character decreases across a period and increases down a group.

Non-metals, on the other hand, are electronegative. They tend to form bonds by gaining electrons.

As the trends in the electro-negativity show, non-metals are found on the right-hand side of the Periodic Table towards the top.

These trends also help us to predict the nature of oxides formed by the elements because it is known to you that the oxides of metals are basic and that of non-metals are acidic in general.