Modern Periodic Table

With the establishment of atomic theory in the first quarter of 20th century and work of physicist Henry Moseley, the chemical behavior of an atom is known to be dependent on its electrical characteristics signified by its *Atomic number* (Z). So Mendeleev's periodic table was modified to include the later developments in so called *Long-form of periodic table*. It is based on modern Periodic Law stated as :

"*The physical and chemical properties of the elements are periodic functions of their respective Atomic numbers*".

In the long form of periodic, the elements having the same electronic configuration in their outer shell were grouped together. The electrons in the outer shell are termed as valence electrons. Valence electrons determine the properties and chemical reactivity of the elements and participate in chemical bonding (discussed later in the chapter).

Hence a major modification in the long form of periodic table, is the arrangement of elements in order of increasing Atomic numbers rather than increasing Atomic weights.

MODERN PERIODIC TABLE Section - 2

In modern periodic table, elements are arranged in horizontal rows (*periods*) and vertical columns (*groups*). In all there are seven periods and eighteen groups. The groups were divided into two categories according to old convention. Now the groups are numbered from 1 to 18. In old convention group nos. were IA, IIA, ...VIIA, IB, IIB .....VIIIB

IA, IIA, IIIA ..... VIIIA : now written as 1, 2, 13, 14, 15, 16, 17, 18

IIIB ..... VIIB : now written as 3, 4, 5, 6, 7

VIII B corresponds to 8, 9, 10 and IB, IIB correspond to11, 12 respectively.

Periods :

Ist Period contains only two elements namely Hydrogen (H), Helium (He). It is called as *shortest period*.

IInd period starts with Lithium (Li) and contains eight elements.

Li, Be, B, C, N, O, F, Ne.

IIIrd period starts with Sodium (Na) and contains eight elements.

Na, Mg, Al, Si, P, S, Cl, Ar.

Note : II and III periods are called as *short-periods*.

IVth period contains eighteen elements starting with Potassium (K).

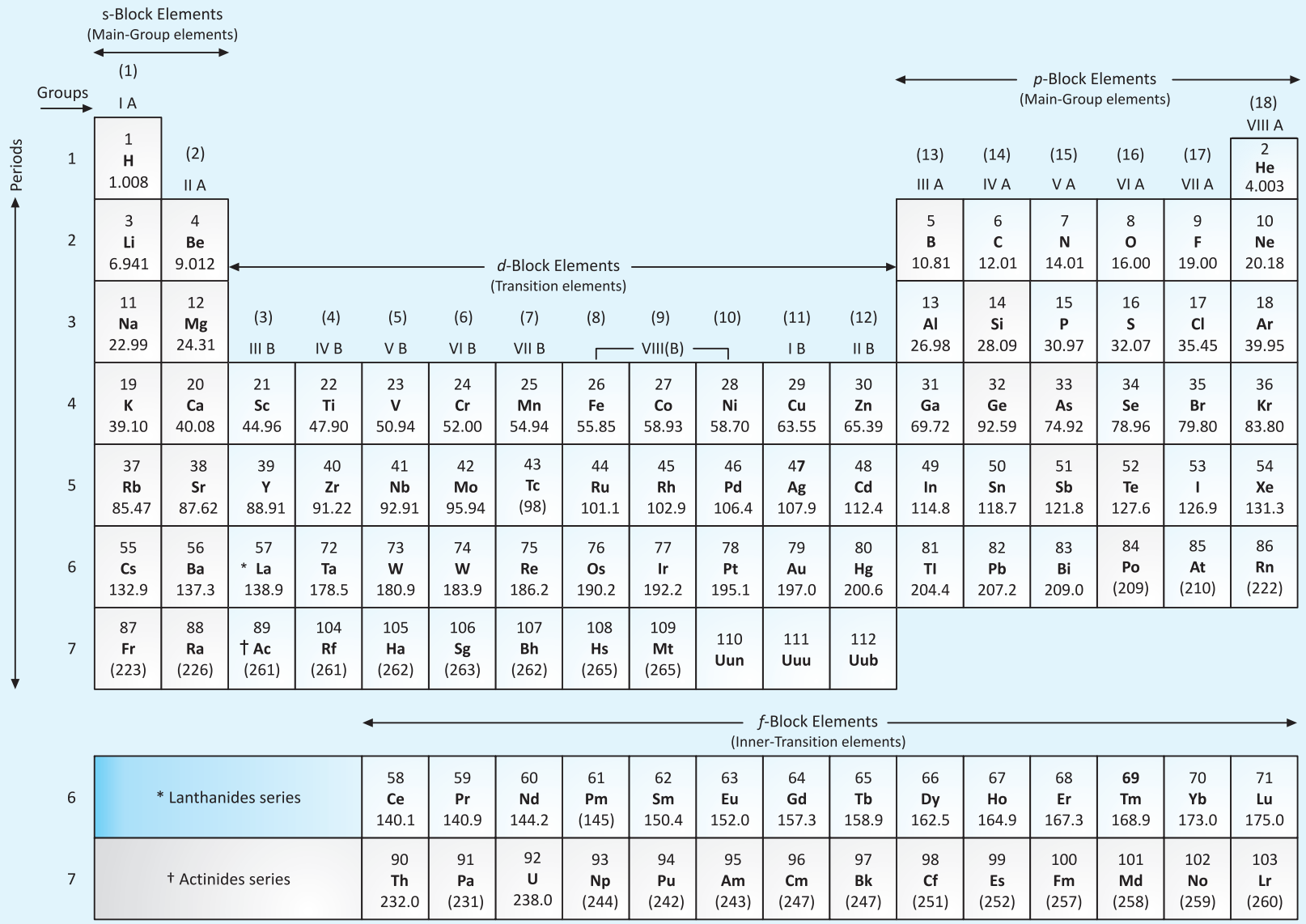
K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr.

Vth period contains eighteen elements starting from Rubidium (Rb).

Rb, ……..., Xe (Xenon).

Note : IV and Vperiods are called as *long-periods*.

Extended or long of the Periodic Table



VI period consists of 32 elements, starting from Cesium (Cs) and ending with Radon (Rn). It is called as *longest period*. Apart from the *representative* and *transition* elements this period also contains *Inner transition* elements called as *Lanthanides* (Ce,……., Lu).

VII period is incomplete period and at present contains 19 elements starting form Francium (Fr). Upto Uranium (U) all the elements are naturally occurring but rest are radioactive with very short half-lives. These also include a part of *inner transition* elements, called as actinides (Th,…Lr)

Groups :

Group 1 consists of H ($1s^1$), Li ($2s^1$), Na ($3s^1$),… The common outermost electronic configuration is ns^1. Elements belonging to this group are called as *Alkali Metals.*

Group 2 consists of Be ($2s^2$), Mg ($3s^2$), Ca ($4s^2$),… The common electronic configuration is ns^2. Elements of this group are called as *Alkaline Earth Metals*.

Group 13 consists of B ($2s^2\ 2p^1$), Al ($3s^2\ 3p^1$),… The common electronic configuration is $ns^2\ np^1$. Elements of this group are called as *Boron Family.*

Group 14 contains C ($2s^2\ 2p^2$), Si ($3s^2\ 3p^2$),… The common electronic configuration is $ns^2\ np^2$. This group is known as *Carbon Family*.

Group 15 contains N ($2s^2\ 2p^3$), P ($3s^2\ 3p^3$),… The common electronic configuration is ns^2np^3. This group is known as *Nitrogen Family*. The elements of this group are also called as *PNICTOGENS* (*poisonous compounds forming elements*).

Group 16 contains O ($2s^2\ 2p^4$), S ($3s^2\ 3p^4$),… The common electronic configuration is $ns^2\ np^4$. This group is known as *Oxygen Family*. The elements of this group are also famous as *CHALCOGENS* (*ore-forming elements*).

Group 17 contains F ($2s^2\ 2p^5$), Cl ($3s^2\ 3p^5$),… The common electronic configuration is $ns^2\ np^5$. Elements of this group are called as *HALOGENS* (*salt forming elements*).

Group 18 (or Zero group) contains He ($1s^2$), Ne ($2s^2\ 2p^6$), Ar ($3s^2\ 3p^6$),… The common electronic configuration is $ns^2\ np^6$. Elements of this group are called as *Inert Gases* or *Noble Gases*.

Classification of periodic table in different blocks :

PERIODIC TABLE

s-block	p-block	d-block	f-block
◈ Elements have last electron in s-orbital i.e. Group 1 and Group 2. ◈ Group No. of any element = no. of electrons in valence shell.	◈ Elements have last electron in p-orbital i.e. Group 13 - 18. ◈ Group No. of any element = no. of electrons in valence shell + 10.	◈ Elements have last electron in d-orbital i.e. Group 3 - 12. ◈ Group No. of any element = no. of elements in penultimate d-shell and valence shell.	◈ Elements have last electron in f-orbital.

H

s - Block

	1	2
1s		
2s	Li	Be
3s	Na	Mg
4s	K	Ca
5s	Rb	Sr
6s	Cs	Ba
7s	Fr	Ra

d - Block

	3	4	5	6	7	8	9	10	11	12
3d	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
4d	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
5d	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
6d	Ac	Rf	Db	Sg	Bh	Hs	Mt	Uuu	Uuu	Uub

p - Block

13	14	15	16	17	18
					He
B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	As	Se	Br	Kr
In	Sn	Sb	Te	I	Xe
Ti	Pb	Bi	Po	At	Rn
-	Uuq	-	-	-	-

f - Block

Lanthanids 4f	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Actinides 4f	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Blockwise Representation of Periodic Table

Features of Groups 1, 2, 13 - 18

- Elements belonging to these groups are in general called as *Representative Elements*
- General Electronic configuration for group 1, 2 can be written as ns^{1-2} and ns^2np^{1-6} for group 13 - 18.

  n : here represents the *number of period* to which a particular elements belongs (principal quantum number).

  The total number of electrons i.e., number of electrons in s & p sub-shells gives the *number of group* to which a particular elements belongs.
- Elements of 1 and 2 groups are also called as s-block elements, as final electron in these elements (also called as differentiating electron) enters s sub-shell. Elements of 13 to 18 groups are called as p-block elements, as differentiating electron in these elements enters p sub-shell.

Features of Groups 3 - 12

- Groups 3 to 12 are known as *transition elements* or d-block elements, as the differentiating electron (last electron) in these elements enters d-sub-shell. General electronic configuration of these elements can be written as $(n-1)\,d^{1\text{-}10}\,ns^{0\text{-}2}$.
- Group 3 has a special feature in sense that, it contains elements in which the differentiating electron enters the f sub-shell, hence these elements are also called as f-block elements apart from being called as *Inner transition elements*. These are placed in two horizontal rows below the table and are called as *Lanthanides* (also called as *Lanthanoides*) and *Actinides* (also called as *Actinoids*).

  General electronic configuration of these elements is :

  Lanthanides : $4f^{n}5d^{0\text{-}1}\,6s^2$

  Actinides : $5f^{n}\,6d^{0\text{-}2}\,7s^2$.

Some other features of the periodic table are as follows :

Typical Elements

Elements of third period are also called as *Typical Elements*. These include Na, Mg, Al, Si, P, S, Cl. The properties of all the elements belonging to a particular group resemble the properties of the corresponding typical element of that group. For example, the general properties of Alkali Metal can be predicted from the behaviour of Na, not Li, the first member of the family.

The typical elements (all having $n = 3$) can take up 18 electrons. Note that, for these elements $3d$ sub-shell is available, but it is not filled i.e., these have vacant d sub-shell. This is not the case with second period elements, hence they have somewhat different properties than the rest of the group or we can say that it is the typical element, which in true sense represents a group.

Bridge Elements

Elements of second period are also called as *Bridge Elements.* The properties of these elements resemble with the properties of elements belonging to third period placed diagonally. This is illustrated as follows.

2 Period	Li	Be	B	C	N	O	F
3 Period	Na	Mg	Al	Si	P	S	Cl

Noble or Inert Gases

Elements of group 18 or zero group are called *Inert* or *Noble Gases*. They have completely filled (2 *or* 8 *electrons in outermost shell*) outermost shells, called as stable configuration. Their valency is zero. They are almost inert in their chemical behaviour. They have weak intermolecular forces in them and hence are gases and exist in monatomic states.

Classification of Elements based on their position is the periodic table

1. Metals

This is the largest class of the elements. This includes elements belonging to 1, 2, 3 to 12 groups (i.e., all transition and inner-transition elements) and some elements of groups 13 to 15 lying near the bottom of the table. The metals are characterized by their nature of readily giving up the electron apart from shinning lusture. The oxides of metals are basic in nature.

2. Non-metals

These do not give up electron, in fact like to take up the electron to form negative ion. These include 10 elements lying to the right side of the table. They are C, N, O, F (2nd period), P, S, Cl (3rd period), Se, Br (4th period) and I (5th period). The oxides of non-metals are acidic in nature.

3. Metalloid

You can very easily observe that metallic character has decreased when one moves to the right of the table across a row. It is observed that some elements lying at the border of metallic and non-metallic behaviour, exhibit both the metallic and non-metallic character, these are called as *metalloids***.** These include 8 elements namely : B, Si, Ge, As, Sb, Te, Po and At. The oxides of metalloids are generally amphoteric in nature.

Note : The elements in group 18 do not behave like metals, nor do they behave like non-metals. So they are classified separately as Noble Gases. Also the element Hydrogen (H) is different from any other element and cannot be easily classified into a particular group (*however it is placed along with the Alkali Metals, though it does not exhibit metallic character*).