CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES ELECTRONIC CONFIGURATIONS AND TYPES OF ELEMENTS: S-, P-, D-, F- BLOCKS

CLASSIFICATION OF ELEMENTS

s-BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron enters in s-orbital, are called s-block elements.

(b) s-orbital can accommodate a maximum of two electrons.

(c) Their general formulae are ns^1 and ns^2 respectively, where n = (1 to 7)

(d) IA group elements are known as alkali metals because they react with water to form alkali. II A group elements are known as alkaline earth metals because their oxides react with water to form alkali and these are found in the soil or earth.

(e) Total number of s-block elements are 14.

(f) Fr^{57} and Ra^{88} are radioactive elements while H and He are gaseous elements.

(g) Cs and Fr are liquid elements belonging to s-block.

p-BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron gets filled up in the p-orbital, called p-block elements.

(b) p-orbital can accommodate a maximum of six electrons. Therefore, p-block elements are divided into six groups which are III A, IV A, V A, VI A, VII A and zero group.

(c) The general formula of p-block elements is $ns^2\ p^{1\text{-}6}$ (where n = 2 to 6)

(d) The zero group elements having general formula ns^2p^6 are inert, because their energy levels are fully filled.

(e) The total number of p-block elements in the periodic table is 30 (excluding He).

(f) There are nine gaseous elements (Ne, Ar, Kr, Xe, Rn, F_2, Cl_2, O_2 and N_2) belonging to p-block. Gallium (Ga) and bromine (Br) are liquids.

(g) The step-like thick lines drawn in the periodic table in the p-block divides elements into metals, nonmetals and metalloids.

d-BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron gets filled up in the d-orbital, called d-block elements.

(b) The d-block elements are placed in the groups named III, IV B, V B, VI B, VII B, VIII, I B and II B.

(c) In d-block elements the electron gets filled up in the d-orbital of the penultimate shell.

(d) d-block elements lie between s & p block elements.

(e) The general formula of these elements is $(n-1)s^2, p^6, d^{1-10}\ ns^{1-2}$ where $n = 4$ to 7.

(f) All of these elements are metals.

(g) Out of all the d-block elements, mercury is the only liquid element.

f-BLOCK ELEMENTS

(a) The element of the periodic table in which the last electron gets filled up in the f-orbital, called f-block elements.

(b) The f-block elements are from atomic number 58 to 71 and from 90 to 103.

(c) The lanthanides occur in nature in low abundance and therefore, these are called rare earth elements.

(d) There are 28 f-block elements in the periodic table.

(e) The elements from atomic number 58 to 71 are called lanthanides because they come after lanthanum (57). The elements from 90 to 103 are called actinides because they come after actinium (89).

(f) All the actinide elements are radioactive.

(g) All the elements after atomic number 92 (i.e. U^{92}) are transuranic elements.

(h) The general formula of these elements is $(n-2)\ s^2\ p^6\ d^{10}\ f^{(1-14)}\ (n-1)\ s^2\ p^6\ d^{0-1}\ ns^2$ where $n = 6$ & 7.

Ex. Elements A, B, C, D and E have the following electronic configurations:

A : $1s^2\ 2s^2\ 2p^1$ B : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

C : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ D : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

E : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

Which among these will belong to the same group in the periodic table?

Sol. Out of these, elements A and B will belong to the same group of the periodic table because they have same outer electronic configuration, $ns^2\ np^1$.

TYPE OF ELEMENTS

Using electronic configuration as the criteria, we generally recognize four general types of elements; the inert gas elements, the representative elements, the transition elements, and the inner transition elements. The classification of the elements into these groups is dependent on the extent to which the s, p, d and f orbitals are filled.

Inert Gases

(a) s and p orbitals of the outer most shell of these elements is completely filled. The outermost electronic configuration is ns^2np^6.

(b) Helium is also inert gas but its electronic configuration is $1s^2$

Representative or Normal Elements

(a) Outermost shell of these elements is incomplete. The number of electrons in the outermost shell is less than eight.

(b) Inner shell are complete.

(c) s-and p-block elements except inert gases are called normal or representative elements.

Transition Elements

(a) Last two shells of these elements namely outermost and penultimate shells are incomplete.

(b) The last shell contains one or two electrons and the penultimate shell may contain more than eight or up to eighteen electrons.

(c) Their outermost electronic configuration is similar to d-block elements i.e. $(n-1)\ d^{1-10}\ ns^{1-2}$.

(d) According to definition of transition elements, those elements which have partly filled d-orbitals in neutral state or in any stable oxidation state are called transition elements. According to this definition Zn, Cd and Hg (IIB group) are d-block elements but not transition elements because these elements have d^{10} configuration in neutral as well as in stable +2 oxidation state.

(e) Because of the extra stability which is associated with empty, half-filled, and fully filled subshells, there are some apparent anomalies in electronic arrangements in the transition

series. This empirical rule is illustrated by the chromium and copper configuration in the first d series of elements:

h	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
3d	1	2	3	5	5	6	7	8	10	10
4s	2	2	2	1	2	2	2	2	1	2

Inner Transition Elements

(a) In these elements last three shells i.e. last, penultimate and penultimate shells are incomplete.

(b) These are related to IIIB i.e. group 3.

(c) The last shell contains two electrons. Penultimate shell may contain eight or nine electrons and pre-penultimate shell contains more than 18, up to 32 electrons.

(d) Their outermost electronic configuration is similar to f-block element i.e. $(n-2)f^{1-14}$ $(n-1)s^2$ $(n-1)p^6$ $(n-1)d^{0-1}ns^2$

PREDICTING ATOMIC NUMBER OF SUCCESSIVE MEMBER IN A GROUP OR FAMILY

Magic Numbers

(a) Knowing the atomic number of the first member of a group, we can write the atomic number of the subsequent elements by adding given magic number

(b) In group IA – Atomic number of H is 1 and atomic number of other element will be as follows –

Magic number $\underbrace{H_1\ 1+2=3}_{2}\ \underbrace{Li\ 3+8=11}_{8}\ \underbrace{Na\ 11+8=19}_{8}\ \underbrace{K\ 19+18=37}_{18}\ \underbrace{Rb\ 37+18=55}_{18}\ Cs$

Determination of period, block and group of an element

(a) **Period number:** The period no. of the element can be predicted from the principal quantum no. (n) of the valence shell.

(b) **Block number:** Last electron enter in which orbital is knows as block no. .

(c) **Group number:** It is predicted from the number of electrons in the valence shell and penultimate shell.

METALS AND NON-METALS

The metals are characterised by their nature of readily giving up the electron and from shinning lusture. Metals comprises more than 75% of all known elements and appear on the left-hand side of the periodic table. Metals are usually solids at room temperature (except mercury). They have high melting and boiling points and are good conductors of heat and electricity. Oxides of metals are basic in nature. (Some metals in their higher oxidation state form acid oxides e.g. CrO_3)

Non-metals do not lose electrons but take up electrons to form corresponding anions. Non-metals are located at the top right-hand side of the periodic table. Non-metals are usually solids or gases at room temperature with low melting and boiling points. They are poor conductors of heat and electricity. Oxides of non-metals are acidic in nature.

METALLOIDS (SEMI METALS)

It is very much clear from the periodic table that non-metallic character increases as we move from left to right across a row. It has been found that some elements lying at the border of metallic and non-metallic behaviour, possess the properties that are characteristic of both metals and non-metals. These elements are called semi metals or metalloids.

The metalloids comprise of the elements B, Si, Ge, As, Sb and Te.

Oxides of metalloids are generally amphoteric in nature.

TYPICAL ELEMENTS:

Third period elements are called as typical elements. These include Na, Mg, AI, Si, P, S, CI.

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 metals (IA) can be predicted from the properties of Na, not Li, the first member of the group.

The properties of the elements of second period differ in the many respects belonging to the same group due to the smaller atomic size and absence of vacant d-orbitals.