

Class - B.Sc. Part(II) Hons.

Subject - Chemistry

Paper - III 'B'

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## TRANSITION METALS AND COMPARATIVE CHEMISTRY OF Sc, Y, La.

Three series of elements are formed by filling 3d, 4d and 5d shells of electrons. These elements together are d-block elements. They are often called transition elements because their position in the periodic table is between the s-block and p-block elements. Their properties are transitional between the highly reactive metallic elements of the s-block, which typically form ionic compounds, and the elements of p-block which are largely form covalent compounds. In s-and p-block electrons are added to outermost shell. In d-block elements electrons are added to the penultimate shell; Elements from group 3 (II B) to 12 (IB) are d-block or transition metal, having incompletely orbital filled at level only elements of group 12 are fully filled d-level. Group 12, the zinc

group has a  $d^0$  configuration and since the d-shell is complete, these metals' compounds are not typical transition metal compounds but they show some differences from the others. The elements make up three complete rows of ten elements and an incomplete fourth row.

### Electronic configuration of transition metals -

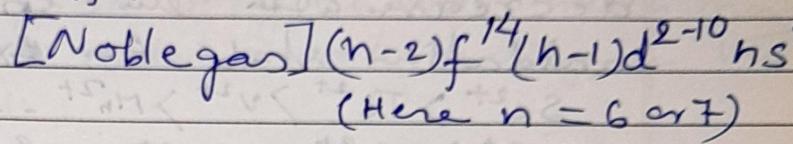
General configuration for 3d and 4d elements are

$$[Noble\ gas] (n-1)d^{1-10} n s^1$$

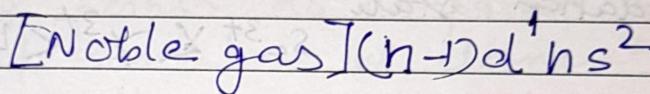
There are some irregularities in electronic configuration due to the very small difference in energy between  $n s$  and  $(n-1) d$  level. Hence the incoming electron may enter into  $n s$  or  $(n-1) d$  subshell. Some times irregularity due to nuclear electron and electron-electron force. Half filled and completely filled d-orbitals are more stable.

than other d-orbitals because the distribution of 5 and 10 electrons in d-orbitals is symmetrical in  $d^5$  and  $d^{10}$  configuration.

General configuration of 5d and 6d series are for the group 4 to 12:



General configuration of group 3 of 6<sup>th</sup> and 7<sup>th</sup> period is

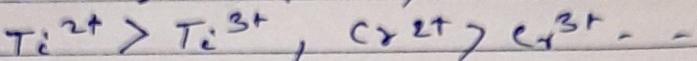
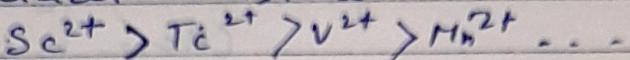


### General characteristics —

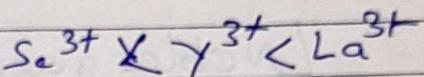
- (1) Atomic radii → the atomic radii of transition metals lie in between those of s-and p-block elements  
the atomic radii of d-block elements in a series decreases with increase in atomic number but after midway the decrease in size is small.  
the atomic radii increase top to bottom as usual but the atomic radii of 5d series after lanthanide is almost equal to the 4d series of the same group due to lanthanide

contraction.

The ionic radii of the different element in same oxidation state in same series decreases with the increase of atomic number. But the ionic radius of same element in different oxidation state decrease with the increase in oxidation state. For example



Value of ionic radii increases as we move down the group in same oxidation state



- ② Metallic properties → All the transition metals elements are metal. Since they have low values for their ionisation energies thus they all show metallic properties. They are good conductor of heat and electricity due to presence of metallic bonding. For example Cu, Ag and Au show exceptionally high thermal and electrical conductivity. These metals are hard, ductile, lustrous, and have high tensile strength. The melting and boiling points are generally very high.

High values are due to covalent bonding which are very strong overlapping between  $(n-1)d$  orbitals.

### ③ Enthalpies of Atomisation ( $\Delta H^\circ$ )

The metals of 3d, 4d and 5d series have high enthalpies of atomisation, so they have much more frequent metal-metal bonding in their compounds.

### ④ on Melting and Boiling points —

metals have very high melting and boiling points as compared to those of representative elements. The high melting and boiling point of these metals are due to the close packed structure of the metals and strong covalent bonding of these metals.

In a series the melting point first increases attain a maximum value then steadily decreases as the atomic number increases. The melting strength of the metal bond depends upon the number of unpaired electrons. So upto  $d^5$  system m.p. increase and  $d^6 - d^{10}$  decrease. The m.p. of Zn, Cd and Hg is low because they have no unpaired electron. Hg is liquid at room temp.

W has the highest melting point among the d-block elements. Lower value in case of Mn and Te can be explained on the basis of the fact that both these elements have exactly half-filled d-orbitals. As a result in both the elements electronic configuration is stable and hence electrons are held tightly by the nucleus so that the delocalisation is less and the metallic bond is much weaker than that in preceding elements.