

CHEMISTRY STUDY MATERIALS FOR CLASS 12 (NCERT BASED REVISION NOTES)

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DATE:- 27/02/2021

d – Block Elements

Introduction:

Periodic table is the systematic arrangement of elements in the order of increasing atomic numbers of the elements. On the basis of electronic configuration the periodic table has been divided into four blocks known as s, p, d and f – block.

Defination: The elements in which last electrons enters the 'd' orbital of the penultimate shell i.e. (n-1) d orbital are called as d-block elements.

The d –block elements are called transition elements and consist of elements lying between s and p –blocks starting from fourth period onwards. These elements have properties which are transitional between those of s and p block elements. All these elements are metal.

The transition elements may be defined as elements whose atoms or simple ions in their common oxidation state contain partially filled d- sub shell. The general electronic configuration of these metals is $(n-1)d^{1-10}ns^{1-2}$

Classification of d –block elements : These are divided into three transition series.

- i) The first transition series. (3d-series) involves the filling of 3d- orbitals and has 10 elements from scandium (Z = 21) to zinc (Z = 30) in the fourth period.
- ii) The second transition series (4d-series) involves the filling of 4d orbitals and has 10 elements from yttrium (Z= 39) to cadmium (Z= 48) in the fifth period.
- iii) The third transition series (5d-series) involves the filling of 5d-orbitals and has 10 elements. The first element of this series is lanthanum (Z= 57) . It is followed by 14 elements (lanthanides or lanthanoids involving filling of 4f- orbitals). The next nine elements are from hafnium (Z =72)to mercury (Z = 80).
- iv) The fourth transition series (6d-series) involves the filling of 6d- orbitals and is incomplete starting from Actinium (Z= 89) and extended upto element with atomic number 104

General Characteristics of Transition Elements:

The members of given transition series do not differ so much from one another as those of non-transition elements (representative elements) of the same period. The reason is that the electronic configuration of transition elements differ only in the number of electrons in (n-1) d- sub shell i.e., the number of electrons in the outermost shell (n) remains the same. The outermost configuration is ns^2 where n is the number of the period to which the given transition elements belongs some important properties of transition elements are as follows.

- 1. Metallic Character.** : d- Block elements have low ionisation energy and hence easily lose electrons to form cations. Furthermore these elements have only one or two electrons in their outermost energy shell i.e., they have a large number of vacant orbitals in the outermost shell which make them form metallic bond. Because of this all the transition elements are metal.

They are generally

- (i) Malleable and ductile
- (ii) Forms alloys with several other metals.
- (iii) They are good conductors of heat and electricity.

However, they differ from non-transition metals in being hard and brittle in certain cases. (Mercury has an exceptional behaviour. It is a liquid at room temperature). It is due to the presence of unpaired electrons in d-orbitals of their atoms which has a tendency for covalent bonding involving d-d overlapping. In a particular series the hardness increases upto the middle with increasing number of unpaired d- electrons. Thus, Cr, Mn and W having maximum number of unpaired d- electrons are very hard metals, while Zn, Cd and Hg are not hard metals due to the absence of unpaired electrons.

- 2. Melting and Boiling Points:** The melting and boiling points of the transition elements are generally very high. This is due to the presence of covalent bonding by the unpaired d- orbital electrons.
- 3. Atomic Radii:** The Variation in atomic radii across each transition series is not as simple as that observed in s and p- block elements. However, following overall trends in the variation of atomic radii across the period are observed.

- i) The atomic radii of the d-block elements of a given series generally decrease with increases in the atomic number. This is due to the fact that with an increase in atomic number the nuclear charge increases which in turn increasingly tend to attract the electron cloud inward resulting in decrease in size. However, the decrease in the radii across a period is not uniform. The decrease in radii of transition metals is small as compared to the decrease in the radii of s and p block elements for the same periods. For ex. The radii of the elements from Cr. To Cu are very close to one another. This may be explained on the basis of screening effect In d- block elements electrons are added to an (n-1) d- sub shell which adds to the primary screening effect. The additional electrons effectively screen the outer ns- electrons from the inward pull of the nucleus. As a result, the size of the atom does not change much from Cr to Cu.
- ii) In a given series the atomic radius decreases from group 3 elements upto the group 10 elements and then increases again towards the end of the series. This anomalous increase in atomic radius towards the end of the series is because of the increased force of repulsion among the added electrons .also the d- orbitals get completely filled in group 11 and 12 elements which also causes a decrease in force of attraction.
- iii) Atomic radius increases on descending down the groups although the increase is not as significant as in case of s and p block elements. The very close similarity between the radii of the elements of second and third transition series, (exp. Zr and Hf , Nb and Ta , Mo and W , Tc and Re etc.) is the consequence of the filling of 4f sub shell.
