TDC Part II
Paper I, Group B
Inorganic Chemistry

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TOPIC:- Periodic Properties and Their Variation along the Series

Periodic Properties and Their Variation along the Series:

The atomic radii, atomic volumes, ionic radii, melting and boiling points, ionization energies and reactivity, standard electrode potential and reducing properties, etc. are the important periodic properties of the d–block elements which vary and have a definite trend, in general, along each series. These will be discussed below:

a) Atomic Radii, Atomic Volumes and Ionic Radii.

The atomic radii generally decrease, with a few exceptions, on moving from left to right in each series of the transition elements due to increased nuclear charge at each step and constant value of the azimuthal quantum number (i.e. l) receiving the last electron.

The d-block elements have low atomic volumes as compared to those of the neighbouring s- and p-block elements. This is due to the fact that in these elements

(n-1) d-subshells are being filled and the increased nuclear charge pulls the electron cloud inwards.

The ionic radii of the d-block elements follow the same trend as the atomic radii, i.e. the radii of the ions having the same charge decrease with increasing atomic number. These properties will be discussed in detail for every series.

b) Melting and Boiling Points

The melting and boiling points of these elements are generally very high showing that they are held by strong forces. The melting and boiling points have the highest values in the middle of the series because, perhaps these elements have the maximum number of unpaired d-electrons available for bonding, detailed account of which will be given ahead for every series.

c) Ionization Energies and Reactivity

The ionization energy values of the d-block elements are fairly high and lie in between those of s- and p-block elements, i.e. these elements are less electropositive than s-block elements and more so than p-block elements. Hence, these elements do not form ionic compounds as readily as s-block elements and form covalent compounds as well. Because of the existence of covalent bonding, they have high heats of sublimation, i.e. a large amount of energy is required to convert them from solid to vapour state. The metal ions also do not get hydrated easily. Due to these parameters, the metal ions have a small tendency to react. Examples will be given in each series.

d) Standard Electrode Potentials and Reducing Properties

The standard reduction potential values of transition elements are generally lower (negative) than that of the standard hydrogen electrode (taken as zero). Thus

they evolve H_2 gas from acids though most of them do that at low rate.

These metals are poor reducing agents which are contrary to the expected behaviour because of the high heats of vaporisation, high ionization energies and low heats of hydration. Example, if available will be given in each series.