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TOPIC :- p-block

Inert pair effect

p –block elements

General Trend

The elements in which the outermost electron enters one of the p-orbitals are referred to as p-block elements. There are six groups of p-block elements (Groups 13, 14, 15, 16, 17 and 18). The general outer electronic configuration is $ns^2\ np^{1-6}$. The covalent radii and metallic character increase on moving down the group and decrease on moving across a period. The ionization enthalpy, electronegativity and oxidizing power increase across a period and decrease down the group. Unlike the s-block elements, which are all reactive metals,

the p- block elements comprise of both metals and non-metals. Since the chemical behavior of metals and non-metals vary, a regular gradation of properties is not observed in p-block elements. Nevertheless some generalizations may be drawn.

Difference in Chemical Behaviour of the First Element

It is interesting to note that the first member of each group differs in many respects from the other members. These differences are quite striking in Groups 13-16. The cumulative effects of small size, high electro-negativity and non-availability of d-orbitals for the first member are responsible for these differences.

Due to non-availability of d-orbitals, the first member can display a maximum coordination number of 4, whereas the others can display higher coordination numbers. Hence we come across species like $[SiF_6]^{2-}$, PCl_5, PF_5, SF_6, but analogous species for carbon, nitrogen and oxygen are not known. The first member, by virtue of having small size and high electronegativity, can form $p\pi - p\pi$ bonds with itself or other elements e.g.

C = C, C ≡ C, N≡ N, C = O, C ≡ N, N = O etc. The heavier members do not display pπ - pπ multiple bonding but can show pπ - dπ bonding.

Inert Pair Effect

The p-block elements display two oxidation states. This is in sharp contrast to the s-block elements that display only one oxidation state, the group number. The higher oxidation state is equal to the group number minus 10 (i.e. number of s and p electrons in the valence shell) and the lower one is two units less than the group number (i.e. number of p-electron in the valence shell). The lower oxidation state becomes more stable on descending the group. This is referred to as the inert pair effect. The higher oxidation state is displayed only when both the ns and np electrons are involved in bond-formation. On the other hand, the lower oxidation state is observed when only the np electron(s) participate in bond formation. On moving down the group the ns electrons tend to remain inert and do not participate in bond formation. This reluctance of the outermost s orbital electron pair to participate in bond formation is called inert pair effect. The reason for this effect is explained in terms of bond energy. On one hand energy is needed to uncouple the s-electrons and on the other hand energy is released during bond formation. If the energy released is sufficient to unpair the s- electrons, then they participate in bond formation, otherwise they do not. The bond energy decreases down the group and hence inert pair effect is prominent for the lower members.