The p-Block Elements

I Group 15 Elements: The Nitrogen Family

1. In group 15 of the Periodic Table, the elements, nitrogen ($_{7}N$), phosphorus ($_{15}P$), arsenic ($_{33}As$), antimony ($_{51}Sb$) and bismuth ($_{83}Bi$) are present.

2. (a) The elements of this group can exhibit various oxidation states ranging between -3 to+ 5.

(b) Maximum covalency of Nitrogen is four because it does not have d- orbitals to expand its covalencv.

3. The atomic (covalent) and ionic radii (in a particular oxidation state) of the elements of nitrogen family (group 15) are smaller than the corresponding elements of carbon family (group 14).

There is a considerable increase in covalent radius from N to P. However, from As to Bi, only a small increase is observed.

4. Nitrogen displays a great tendency to form pπ-pπ multiple bonds with itself as well as with carbon and oxygen. The tendency to exhibit pπ-pπ multiple bonding decreases as we move down the group.

5. Group 15 elements are more electronegative than group 14 elements. Electronegativity decreases on moving down the group from N to Bi.

6. All elements of group 15 form gaseous hydrides of the type MH_3.

(a) The basic strength of the hydrides decreases as we down the group. Thus, NH_3 is the strongest base.

$NH_3 > PH_3 > ASH_3 > SbH_3$

(b) The thermal stability of the hydrides decreases as the atomic size increases,.

7. N cannot form NX_5 because of non-availability of d-orbitals. Bi cannot form a BiX_5 because of reluctance of 6s electrons of Bi to participate in bond formation.

8. Nitrogen forms a number of oxides. The rest of the members (P, As, Sb and Bi) of the group form two types of oxides: E_20_3 and E_20_5.

II Group 16 Elements

9. In group 16 of the Periodic Table, elements, oxygen ($_{8}O$), sulphur ($_{16}S$), selenium ($_{34}Se$), tellurium ($_{52}Te$) and polonium ($_{84}Po$) are present.

10. The elements have the electronic configuration ns2np4 for their valence shells. The first element of the group 16 differs in its chemical behaviour from that of other

members of the group due to its small size and high electronegativity.

11. The metallic character increases with increase in atomic number. The first four elements are non- metallic in character. Non-metallic character is strongest in O and S, weaker in Se and Te while Po is metallic.

12. Atomic and ionic radii increases from top to bottom, due to increase in the number of shells.

13. Ionisation enthalpy decreases down the group, due to increase in size. Elements of group 16 have lower ionisation enthalpy values as compared to group 15 in the corresponding periods. This is due to the fact that group 15 elements have extra stable half-filled p-orbital electronic configurations.

14. Oxygen has less negative electron gain enthalpy than sulphur due to compact nature of oxygen atom.

15. Next to F, O has highest electronegativity value among'the elements. Within the group, electronegativity decreases with increase in atomic number.

16. The tendency for catenation decreases as we go down the group.

17. All the elements of the group form volatile ,hydrides.

(a) The volatility increases from water to hydrogen sulphide and then declines. This is evident in their boiling point. Increasing order-of boiling points of hydrides is $H_2S < H_2Se < H_2Te < H_20$. Down 27. the group boiling point increases because of increase in molecular weight which increases the van der Waal's forces of 28. interaction. H_20 has abnormally high b.p. due to hydrogen bonding.

(b) The thermal stability of the hydrides decreases in the order:
$H_20 > H_2S > H_2Se > H_2Te > H_2Po$.

(c) The strength of the hydrides as acids increases in the order:
$H_20 < H_2S < H_2Se < H_2Te$.

18. All the elements of group 16 form binary halides.

19. (a) S, Se and Te form a number of oxo-acids. Among the oxo-acids of S, sulphuric acid is most important.

(b) Sulphurous acid (H_2S0_3) and thiosulfiiric acid ($H_2S_20_3$) are unstable and cannot be isolated. They exist only in aqueous solutions or in the form of their salts.

III Group 17 Elements

20. The group 17 of the Periodic Table contain fluorine ($_9F$), chlorine ($_{17}Cl$), bromine ($_{35}Br$), iodine ($_{53}I$) and astatine ($_{55}At$).

21. Electronic configuration is $ns^2\ np^5$ for valence shells.

22. Halogens have the smallest atomic radii in their respective periods due to maximum effective nuclear change.

23. The first ionisation energies are relatively high but decreases down the group. Iodine can lose an electron and form I^+ ion.

24. Electron affinity varies as Cl > F > Br > I

25. F is the, most electronegative element known. Electronegativity decreases down the group. Halogens are good oxidising agfents. The oxidising power decreases down the group.

27. (a) Reactivity varies as $F_2 > Cl_2 > Br_2 > I_2$

(b) Order of ionic character in M – X bond is M-F>M-Cl>M-Br>M-I

28. Strength of hydrohalic acids varies as: HF<HCl<HBr<HI

The order of B.P is HCl < HBr < HI < HF

29. (a) Hypohalous acids are all weak acids and exist in solution only. Acid strength decreases down the group. HOCl > HOBr > HOI

(b) Acid strength increases as the number of O-atoms increases for a given halogen atom. $HOCl < HClO_2 < HClO_3 < HClO_4$

IV Group 18 Elements: The Noble Gases

30. In group 18 of the Periodic table, elements helium ($_2$He), neon ($_{10}$Ne), argon ($_{18}$Ar), krypton ($_{36}$Kr), xenon ($_{54}$Xe) and radon ($_{86}$Rn) are present. They are collectively called as noble gases.

31. Noble gases are located at the end of each period. Their valence shell orbitals are fully occupied.

32. They are monoatomic and are sparingly soluble in water.

33. Xe forms fluorides XeF_2, XeF_4 and XeF_6.

34. $Xe0_3$ is trigonal pyramidal in shape whereas $XeOF_4$ is square pyramidal.

35. Uses:

(a) He is a non-inflammable gas, lighter than air, therefore, used in filling balloons for meteorological observations.

(b) Ar is used to provide an inert atmosphere.