Chemistry Study Materials for Class 11

(NCERT Quick Revision Notes of Chapter- 11)

Ganesh Kumar Date: -27/12/2020

The p- Block Element

- **Some Compounds of Boron**

(i) Borax: Borax is a white crystalline solid.

It contains tetranuclear units. $[B_4O_5(OH)_4]^{2-}$

Its formula is $Na_2[B_4O_5(OH)_4]\cdot 8H_2O$

Borax dissolves in water to give an alkaline solution

$$Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$$

Orthoboric acid

Borax is used as a water softner and cleaning agent.

(ii) Orthoboric acid (H_3BO_3) or $B(OH)_3$: Boric acid can be prepared by the acidification of aqueous solution of borax.

$$Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 4H_3BO_3 + 2NaCl$$

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow 4H_3BO_3 + Na_2SO_4$$

It can also be prepared by the hydrolysis of boron compounds.

$$BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$$

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$

Physical properties of boric acid:

(i) It is a white crystalline solid.

(ii) It is soft soapy in touch.

(iii) It is sparingly soluble in cold water but fairly soluble in hot water.

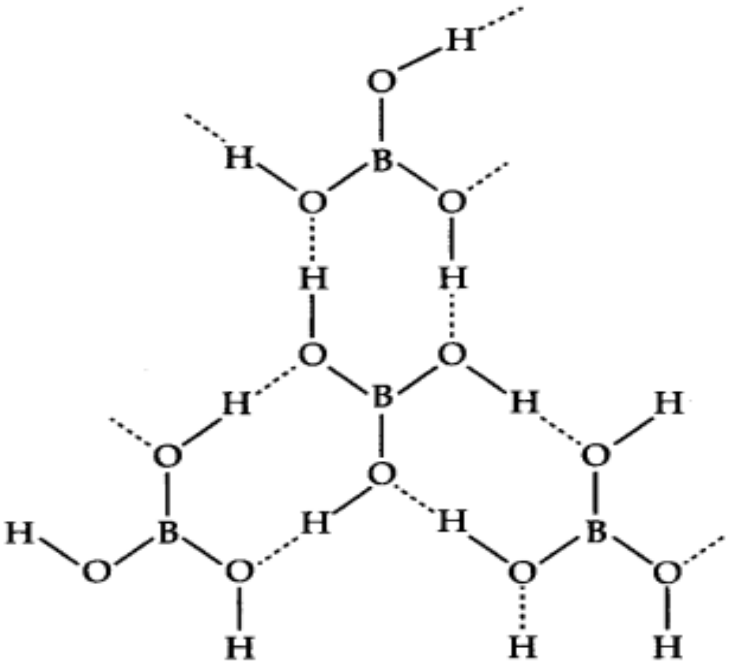
Uses:

(i) In the manufacture of heat resistant borosilicate glazes.

(ii) As a preservative for milk and food stuffs.

(iii) In the manufacture of enamels and glazes in pottery.

Structure of boric acid



Structure of boric acid; the dotted lines represent hydrogen bonds

Diborane, (B_2H_6):

The series of compounds of boron with hydrogen is known as boranes.

Diborane is prepared by the reduction of boron trifluoride with $LiAlH_4$ in diethyl ether.

$$4BF_3 + 3LiAlH_4 \longrightarrow 2B_2H_6 + 3LiF + 3AlF_3$$

Laboratory method of preparation. In laboratory diborane is prepared by the oxidation of sodium borohydride with iodine.

$$2NaBH_4 + I_2 \longrightarrow B_2H_6 + 2NaI + H_2$$

Industrial method of preparation: On industrial scale, diborane is prepared by reduction of BF_3 with sodium hydride.

$$2BF_3 + 6NaH \xrightarrow{450\ K} B_2H_6 + 6NaF$$

Physical Properties:

(i) Diborane is a colourless, highly toxic gas with a b.p. of 180 K.

(ii) Diborane catches fire spontaneously upon exposure to air.

(iii) Higher boranes are spontaneously flammable in air.

Chemical properties:

(i) Boranes are readily hydrolysed by water to form boric acid

$$B_2H_6(g) + 6H_20(Z) \longrightarrow 2B(OH)_3(aq) + 6H_2(g)$$

(ii) It burns in oxygen evolving an enormous amount of heat

$$B_2H_6 + 30_2 \longrightarrow B_20_3 + 3H_20$$

(iii) Reaction with Lewis base:

Diborane on treatment with Lewis bases undergo cleavage reactions to form borane which then reacts with Lewis bases to form adducts.

$$B_2H_6 + 2NMe_3 \longrightarrow 2BH_3.NMe_3$$

$$B_2H_6 + 2CO \longrightarrow 2BH_3.CO$$

• Group 14 Elements:

The Carbon Family Group 14 includes carbon (C), silicon (Si), Germanium (Ge), tin (Sn) and lead (Pb).

General electronic configuration of carbon family is ns^2np^1.

Carbon: Carbon is the seventeenth most abundant element by weight in the earth's crust.

(i) It is available as coal, graphite and diamond. In combined state it is present in metal carbonates, hydrocarbons and carbon dioxide gas (0.03%) in air.

(ii) Naturally occurring carbon contains two stable iosotopes 12C and 13C and third isotope 14C. 14C is a radioactive isotope with half life 5770 years and is used for radiocarbon dating.

Covalent radius: Covalent radius expected to increase from C to Si. From Si to Pb small increase is found.

Reason: Due to the addition of a new energy shell in each succeeding element. The increase in covalent radii from Si to Pb is small due to ineffective shielding of the valence electrons by the intervening d- and f orbitals.

Ionization Enthalpy: The first ionization enthalpies of group 14 elements are higher than those of the corresponding group 13 elements.

Reason: Because effective nuclear charge increases and size of the atoms becomes smaller. First ionization enthalpy decreases on moving down the group from carbon to tin.

The decrease is very sharp from carbon to silicon while there is slight increase in the first ionization enthalpy of lead as compared to that of tin.

Electronegativity: Group 14 elements are smaller in size as compared to group 13 elements that's why this group are slightly more electronegative than group 13. From Si to Pb it is almost same. Small increase in ionization enthalpy from Sn to Pb is due to the effect of increased nuclear charge outweighs the shielding effect due to the presence of additional 4f- and 5d-electrons.

Physical properties:

(i) All the elements of group 14 elements are solids. They are less metallic than group 13.

(ii) M.P. and boiling points of group 14 elements are generally high.

Chemical properties:

Carbon and silicon mostly show +4 oxidation state. Germanium forms stable compounds in +4 state and only few compounds in +2 states.

Tin forms compounds in both oxidation states. Lead forms compounds in +2 state are stable and in +4 state are strong oxidising agents.

• Anomalous Behaviour of Carbon

Carbon, differs from the rest of the member of its family. The main reason for the anomalous behaviour is:

(i) exceptionally small atomic and ionic size

(ii) higher ionization enthalpy

(iii) absence of d-orbitals in the valence shell.

(iv) Higher electronegativity.

It can be explained as follows:

=> Since carbon has only s and p-orbitals it can accommodate only four pairs of electrons ; other member can expand their covalence due to the presence of d-orbitals.

=> Carbon can form Pπ-Pπ multiple bonds with itself and other atoms having small size and high electronegativity.

For example, $C = C$, $C \equiv C$, $C = O$, $C = S$ and $C \equiv N$

Heavier elements do not form Pπ-Pπ bonds because their atomic orbitals are too large and diffuse to have effective overlapping.

=> Carbon atoms have the tendency to link with one another through covalent bonds to form chains and rings. This property is called catenation.

Down the group property to show catenation decreases.

The order of catenation is C >> Si > Ge ≈ Sn

Lead does not show catenation.

****