

Hydrogen Bond

1. It is a weak electrostatic force present between positively charged hydrogen atom of a Polar molecule and a highly electronegative atom carrying negative charge the highly electronegative atom may be present in the same molecule (or) in a different molecule.
2. Hydrogen bond was proposed by Latimer and Rodebush.
3. The energy of hydrogen bond varies from 2 to 10 K.cals/mole or 10-50 kj / mole.
4. Hydrogen bond is weaker than covalent bond and stronger than vanderwaals force of attraction.
5. Most electronegative atoms like Fluorine, Oxygen, and Nitrogen only can involve in hydrogen bond. Chlorine atom very rarely involves in hydrogen bond.
6. Hydrogen bond present in the same molecule is known as intra molecular hydrogen bond.
7. Due to intramolecular hydrogen bonding, ring formation (or) chelation occurs.
EX for intra molecular hydrogen bond O- Chlorophenol, O- Nitro phenol, O- Nitro aniline, O- Hydroxy benzaldehyde (Salicylaldehyde), O- Hydroxy benzoic acid (Salicylic acid)
8. Substances having intramolecular hydrogen bonds are less water soluble, are steam volatile, have low boiling points.
9. Hydrogen bond formed between different polar molecules is known as inter molecular hydrogen bond.

Ex. Water, ammonia, hydrofluoric acid, ortho phosphoric acid, ortho boric acid, p- nitro phenol, p- hydroxy benzaldehyde, p- hydroxy benzoic acid, Primary alcohols, fatty acids and primary amines.

10. Substances having inter molecular hydrogen bonds exist as associated molecules and have higher boiling points than normal liquids. Water, ammonia, hydrofluoric acid, methyl alcohol and ethyl alcohol etc., are associated liquids.

11. Benzene, carbon disulphide, carbontetrachloride, acetone, ether, bromine, nitro benzene etc., is normal liquids as they have no hydrogen bonds.

12. The order of boiling points Of hydrides in

i. VA group is $NH_3 > PH_3 < AsH_3 < SbH_3$

ii. VIA group is $H_2O > H_2S < H_2Se < H_2Te$

iii. VIIa group is $HF > HCl < HBr < HI$

iv. IVA group is $CH_4 < SiH_4 < GeH_4 < SnH_4$

* The boiling points of NH_3, H_2O, HF are more than those of PH_3, H_2S and HCl respectively because inter molecular hydrogen bonds are present in NH_3, H_2O, HF . Hydrogen bonds are not present in PH_3, H_2S and HCl

*The boiling point gradually increases from CH_4 to SnH_4 because there are no hydrogen bonds in $CH_4, SiH_4, GeH_4, SnH_4$

13. The boiling point of water is more than that of hydrofluoric acid though the hydrogen bond in HF is very strong. This is due to

a. The presence of more number of hydrogen bonds in one mole of water than in one mole of HF.

b. Hydrofluoric acid exists as $(\text{HF})_n$ molecules in vapour state. Water exists as only H_2O molecules in vapour state. So heat of vaporisation of hydrofluoric acid is less than that of water.

14. The molecular weight of formic acid (or) acetic acid determined by using its solution in a non polar solvent like benzene is twice the expected value. This is due to the dimerisation of acid molecules by hydrogen bonds.

15. Ice is a tetrahedral three dimensional polymer. In ice every water molecule involves in four hydrogen bonds.

16. Covalent substances like Glucose, Urea, Sugar, Ammonia, ethyl alcohol etc. dissolve freely in water because they form hydrogen bonds with water.

17. In a hydrated cation, the bond between water molecule and cation is dative bond. In a hydrated anion, the bond between water molecule and anion is hydrogen bond.

* In a hydrated salt, having odd number of water molecules one water molecule is bonded to the anion and the remaining water molecules are bonded to the cation.

Examples: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$; $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$