Chemistry Study Materials for Class 11 (NCERT Based Notes of Chapter- 04)

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CHEMICAL BONDING AND MOLECULAR STRUCTURE

Polarity of bonds – Dipole moment

When a covalent bond is formed between 2 similar atoms, the shared pair of electrons is equally attracted by the two atoms. So the electron pair is exactly between the two nuclei. The bond so formed is called a non-polar covalent bond.

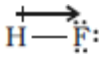
But when the covalent bond is formed between 2 dissimilar atoms, the shared electron pairs are more attracted by one of the atoms. So one atom gets a slight negative charge (δ^-) and the other gets a slight positive charge (δ^+). Such molecules are called polar molecules. E.g. HCl, HF, H_2O, HI etc.

The polarity of a molecule is expressed in terms of *dipole moment* (μ). It is defined as *the product of the magnitude of charge at one end (Q) and the distance between the charges (r)*.

Mathematically, **μ = Q x r**.

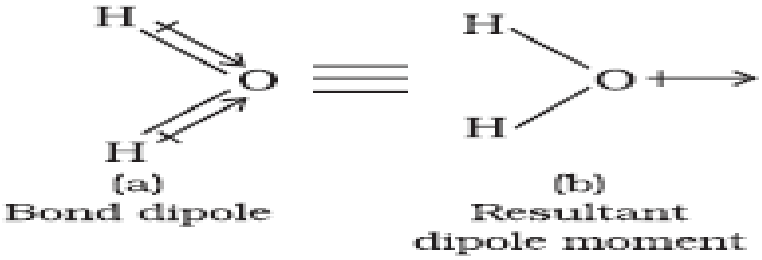
The unit of dipole moment is Coulomb metre (Cm). But it is usually expressed in the unit Debye (D). 1D = 3.336 x 10^{-30} Cm. Dipole moment is a vector quantity.

i.e it has both magnitude and direction. It is denoted by a small arrow with tail on the positive centre and head pointing towards the negative centre.

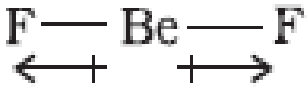
e.g.: HF 

In the case of poly atomic molecules, dipole moment depends on the individual bond dipoles and the spatial arrangement of bonds. Here the dipole moment of the molecule is the vector sum of the bond dipoles of various bonds.

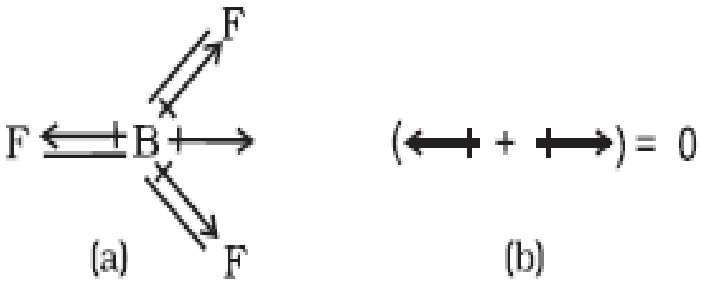
e.g. H_2O



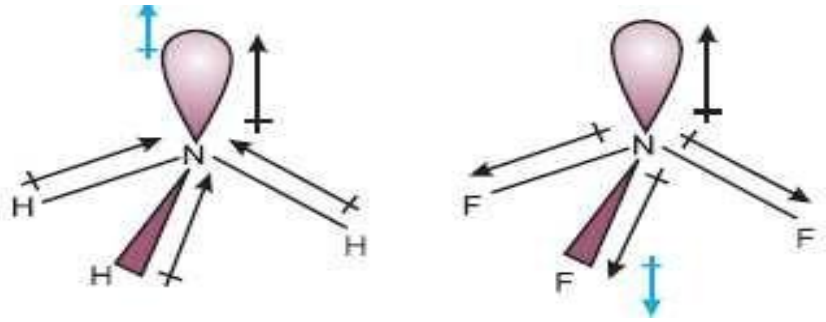
For BeF_2, the net dipole moment is zero, since the two equal bond dipoles are in opposite directions and cancel each other.



In BF_3, the net dipole moment is zero. Here the resultant of any 2 bond dipoles is equal and opposite to the third.



Both ammonia **(NH_3)** and nitrogen fluoride **(NF_3)** are pyramidal in shape. *Even though F is more electro negative than H, the net dipole moment of NF_3 is smaller than that of NH_3*. This is because in the case of NH_3, the orbital dipole due to lone pair is in the same direction as the resultant dipole moment of the three N – H bonds. But in NF_3, the orbital dipole is in the opposite direction to the resultant dipole moment of the three N-F bonds. So the dipole moments get partially cancelled.



NH_3 (μ = 1.47D) NF_3 (μ = 0.23D)

Covalent character in ionic bonds – Fajans Rules

The partial covalent character of ionic bonds was explained by Fajans in terms of the following rules:

1) The smaller the size of the cation and the larger the size of the anion, the greater the covalent character of an ionic bond.

2) The greater the charge on the cation, the greater the covalent character of the ionic bond.

3) For cations of the same size and charge, the ion with electronic configuration $(n-1)d^{n}ns^{0}$ is more polarising than the ion with a noble gas configuration $(ns^{2}\ np^{6})$.

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