

Dipole moment of Organic Compounds.

(1) Due to differences in electronegativity polarity develops between two adjacent atoms in the molecule (i.e., in a bond). The degree of polarity of a bond is called dipole moment. Dipole moment is represented by μ and its unit is Debye (D).

$$\mu = e \times l$$

Where, e = magnitude of separated charge in e.s.u., l = internuclear distance between two atoms i.e., bond length in cm.

The dipole moment is denoted by arrow head pointing towards the positive to the negative end (\rightarrow).

(2) Dipole moment of the compound does not depend only on the polarity of the bond but also depends on the shape of the molecule. Dipole moment of symmetrical compound is always zero, ($\mu = 0$). Symmetrical compounds are those compounds which fulfil following two conditions,

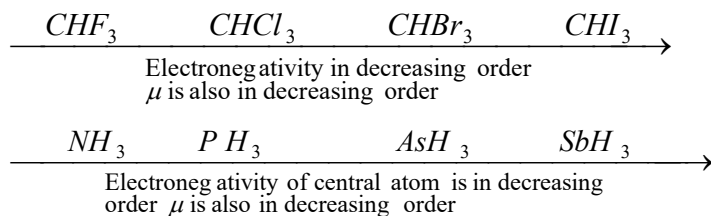
(i) Central atom is bonded with the same atoms or groups. Examples:
 $H_2, BF_3, CS_2, CH_2 = CH_2, CH \equiv CH$
 Symmetrical molecules

(ii) Central atom should have no lone pair of electrons.

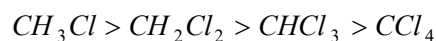
Examples: CCl_4, CH_4, BH_3, CO_2 Symmetrical molecules $H_2\ddot{O}, H_2\ddot{S}$ Unsymmetrical molecules

Note: Compounds which have regular tetrahedral structure has no dipole moment.

(3) $\mu \propto$ electronegativity of central atom or surrounding atoms present on the central atom of the molecule.



Note: Decreasing order of dipole moment in $CH_3Cl, CH_2Cl_2, CHCl_3$ and CCl_4 is

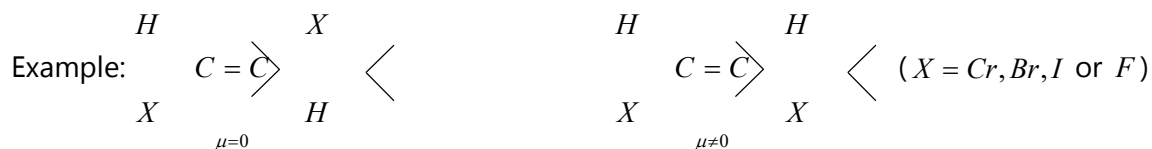


$$\mu = 1.86 \text{ D} \quad 1.62 \text{ D} \quad 1.03 \quad 0$$

Alkynes has larger dipole moment because the electronegativity of $sp - C$ is more than that of $sp^2 - C$.

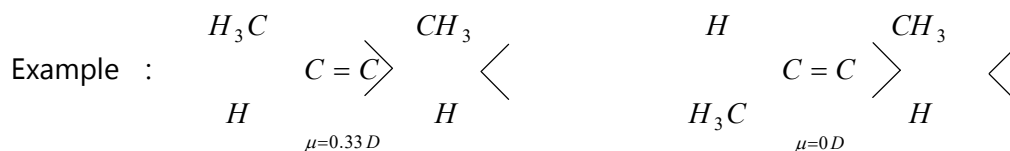
(4) $\mu_{cis} > \mu_{trans}$ in geometrical isomers.

(5) Dipole moment of the trans derivative of the compound $(a)(b)C = C(a)(b)$ will only be zero if both a and b will be in the form of atoms.



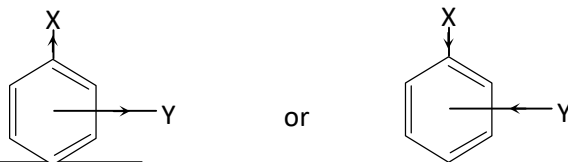
If both will not be atoms then μ_{trans} may or may not be zero.

If group have non-linear moments, then the dipole moment of the trans isomer will not be zero.
If group have linear moments, then the dipole moment of the trans isomer will be zero.



(6) Dipole moment of disubstituted benzene

(i) When both groups X and Y are electron donating or both groups are electron withdrawing



Then, $\mu = \sqrt{\mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos \theta}$

Where, μ_1 = dipole moment of bond $C-X$, μ_2 = dipole moment of bond $C-Y$, θ = angle between X and Y .

If value of θ will be more, then $\cos \theta$ will be less. Hence, dipole moment will be as,

$\frac{o\text{-derivative} > m\text{-derivative} > p\text{-derivative}}{\mu \text{ in decreasing order}} \rightarrow$

(ii) When one group is electron withdrawing and the other group is electron donating then,

$$\mu = \sqrt{\mu_1^2 + \mu_2^2 - 2\mu_1\mu_2 \cos \theta}$$

Hence, dipole moment is as follows,

$\frac{o\text{-derivative} > m\text{-derivative} > p\text{-derivative}}{\mu \text{ in decreasing order}} \rightarrow$