

Chemistry Study Materials for Class 11

(NCERT Based Notes of Chapter- 12)

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SOME BASIC PRINCIPLES AND TECHNIQUES

Electron displacement effects in covalent bonds

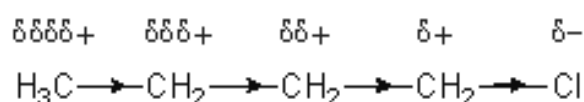
In an organic molecule, the electron displacement may take place either under the influence of an atom or in the presence of an attacking reagent. The important types of electron displacement effects are inductive effect, electromeric effect, resonance effect and hyper conjugation.

1. Inductive effect (I - effect):

It is a permanent effect arising due to the shifting of sigma electrons through a carbon chain in presence of an atom or group of atom (having different electronegativity) attached to a carbon chain. This effect propagates only through C – C σ bonds. This effect decreases rapidly as the number of C atoms increases.

E.g. 1-chlorobutane $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{Cl}$

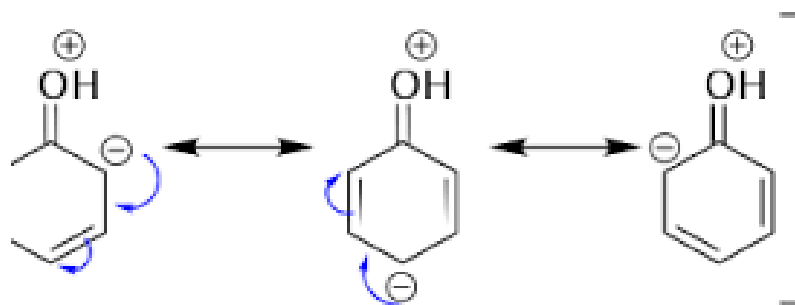
Here Cl is more electronegative than C. So the electron pair in the C – Cl bond is shifted towards Cl and it gets a slight –ve charge (δ^-) and C gets a slight +ve charge (δ^+). This carbon attracts the electron density from the second carbon and so the 2nd carbon gets a relatively smaller positive charge ($\delta\delta^+$).



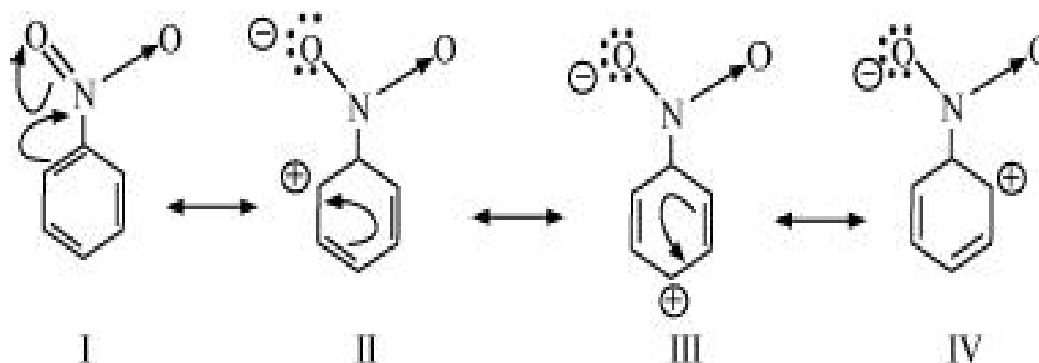
Here Cl atom attracts electron towards it. So we can say that Cl atom has electron withdrawing effect or –I effect (negative inductive effect). So groups which have the ability to attract electron pairs towards it are called – I effect.

Example for such groups are –X (F, Cl, Br, I), nitro (–NO₂), Cyano (CN[–]), Carboxy (–COOH), ester (–COOR), aryloxy (–OAr) etc.

Groups which donate electron pairs towards the carbon chain are said to have +I effect or electron donating (releasing) groups. Example for such groups are alkyl groups like methyl (–CH₃), ethyl (–CH₂–CH₃) etc.



b) **Negative Resonance Effect (-R effect):** Here the transfer of electrons is towards the atom or substituent group attached to the conjugated system. E.g. -R effect in nitrobenzene:



The presence of alternate single and double bonds in an open chain or cyclic system is termed as a conjugated system.

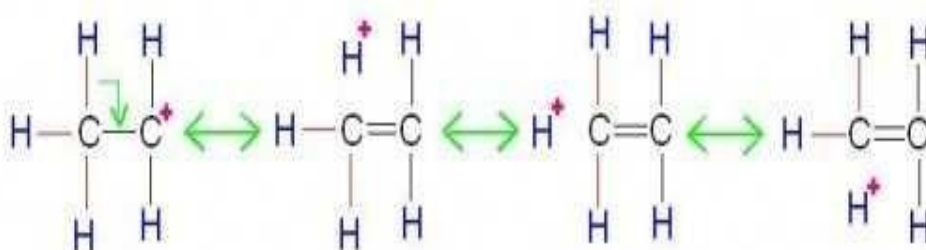
E.g. for +R effect groups: - halogen, -OH, -OR, -OCOR, -NH₂, -NHR, -NR₂, -NHCOR etc.

E.g. for -R effect groups: -COOH, -CHO, >C=O, -CN, -NO₂ etc.

4. Hyper conjugation:

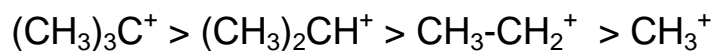
It is a permanent effect. In this effect the σ electrons of C—H bond of the alkyl group enter into partial conjugation with the unsaturated system or with the unshared p orbital. i.e. the σ electrons of C—H bonds get delocalised.

e.g. ethyl cation ($\overset{+}{\text{C}}\text{H}_3\text{-CH}^+$)



Hyper conjugation stabilizes the carbocation because electron density from the adjacent σ bond helps in dispersing the positive charge. In general, the greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyper conjugation interaction and stabilization of the cation.

Thus the relative stability of carbocations is in the order:



Here tertiary carbocation has 9, isopropyl has 6, ethyl carbocation has 3 and methyl carbocation has zero hyper conjugative structures.

Hyper conjugation is also called no-bond resonance and it is also possible in alkenes and alkyl arenes.
