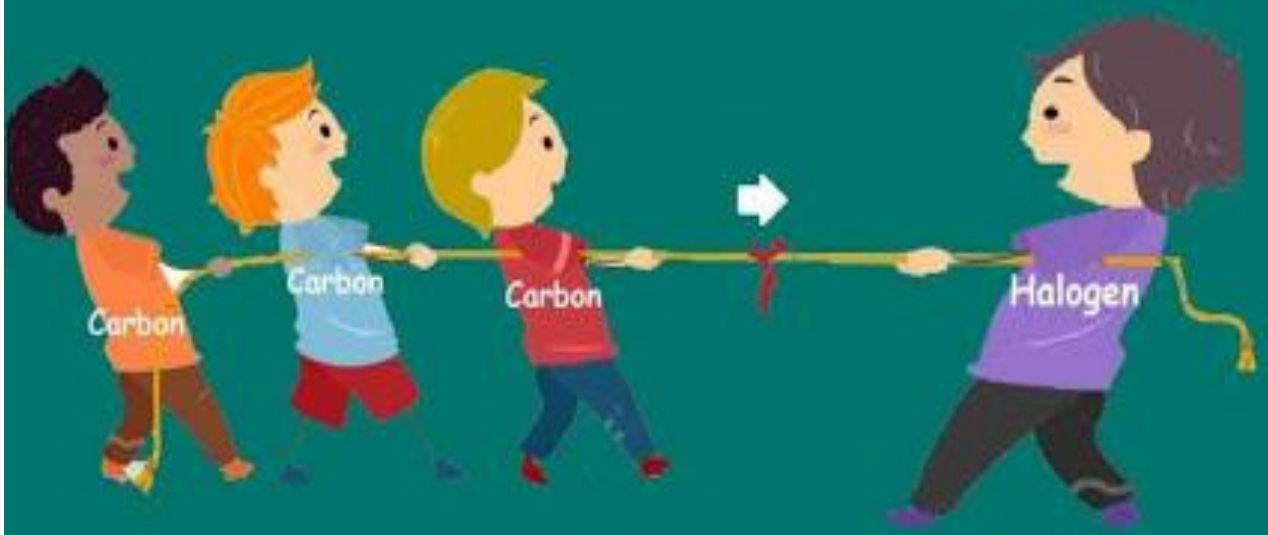
Inductive effect

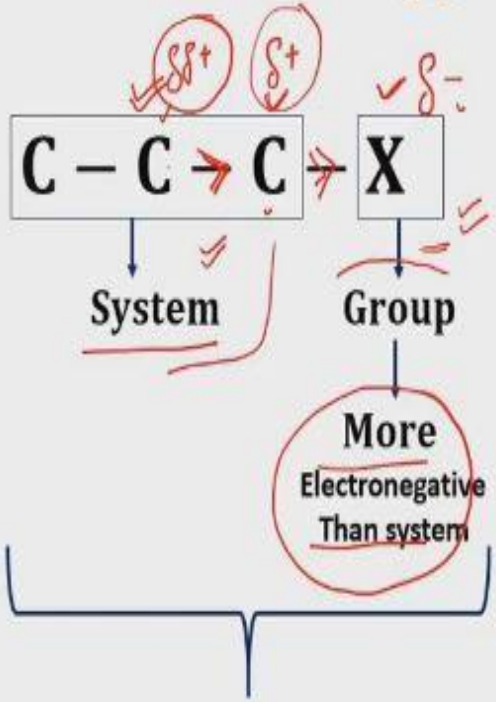
The effect of the sigma electrons displacement toward the highly electronegative atom is known as the inductive effect (I).

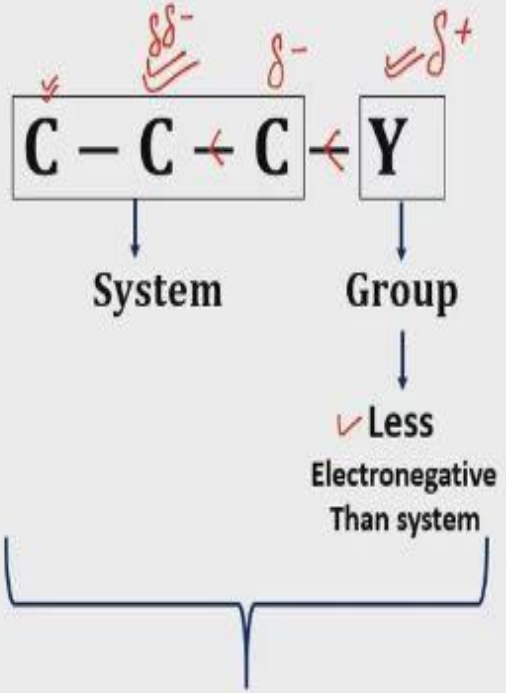
Inductive Effect



Electron Shift towards more electronegative Atom.
It operates on (Sigma) σ bonded electron.
It is a permanent effect.

Types of Inductive Effect





–I effect

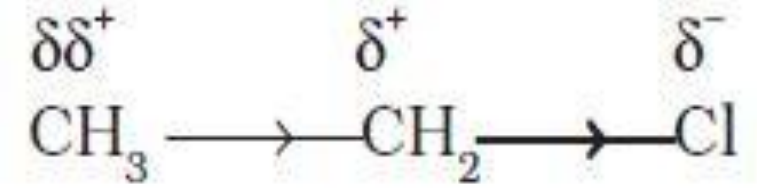
"X" is called **– I effecting group**

+I effect

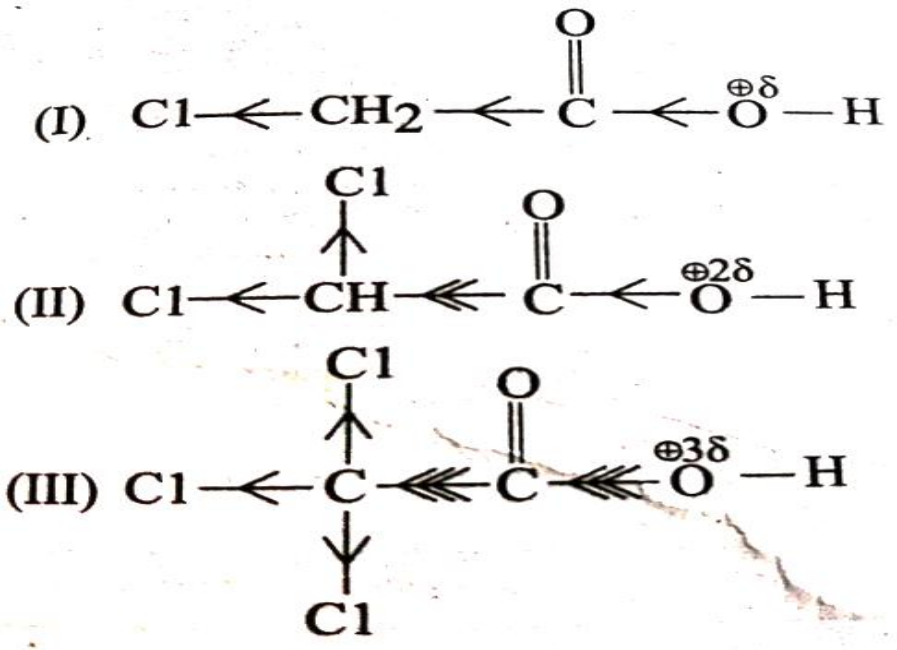
"Y" is called **+ I effecting group**

-I Effect

When an electronegative atom, such as a halogen, is introduced to a chain of carbon atoms the resulting unequal sharing of electrons generates a positive charge which is transmitted through the chain.



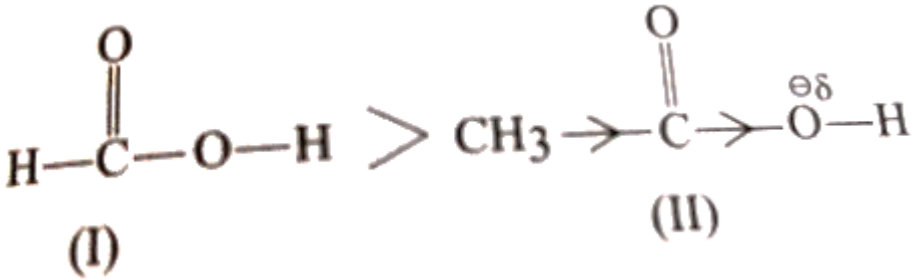
As the number of electronegative atoms or groups increase; the -I effect increase



the acidity order for the above compounds would be, III > II > I.

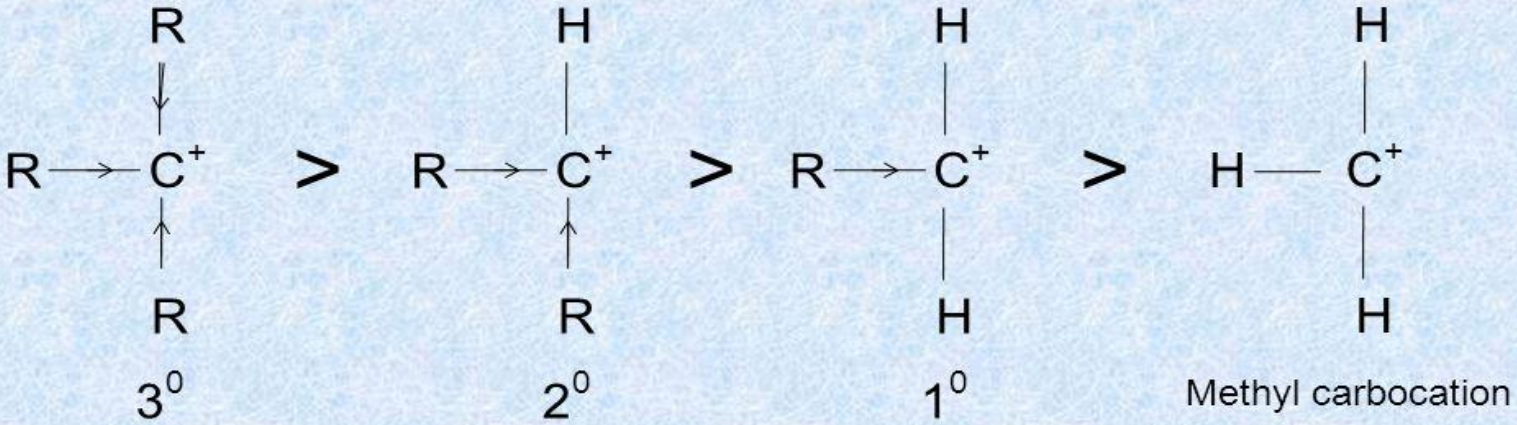
+I Effect

When a group tends to donate electrons, such as an alkyl group, is introduced to a carbon chain, the charge is relayed through the chain and this effect is called +I Effect



(a) Inductive effect

More the number of alkyl group on the carbon atom carrying the +ve charge, greater would be the dispersal of the charge and hence more stable would be the carbocation. Thus, the stability of the carbocations decereases in the order: 3°> 2°> 1°> ;



Stability decreases as +I-effect of the alkyl group decreases

$(CH_3)\overset{+}{C}$ > $CH_3\overset{+}{C}HCH_3$ > $CH_3CH_2\overset{+}{C}H_2$ > $CH_3CH_2^+$ > CH_3^+

Mesomeric effect

It is defined as the polarity produced in the molecule by the interaction of two pi bonds or between a pi bond and lone pair of electrons present on an adjacent atom.

The mesomeric effect is negative (**−M**) when the substituent is an electron-withdrawing group and the effect is positive (**+M**) when the substituent is an electron releasing group.

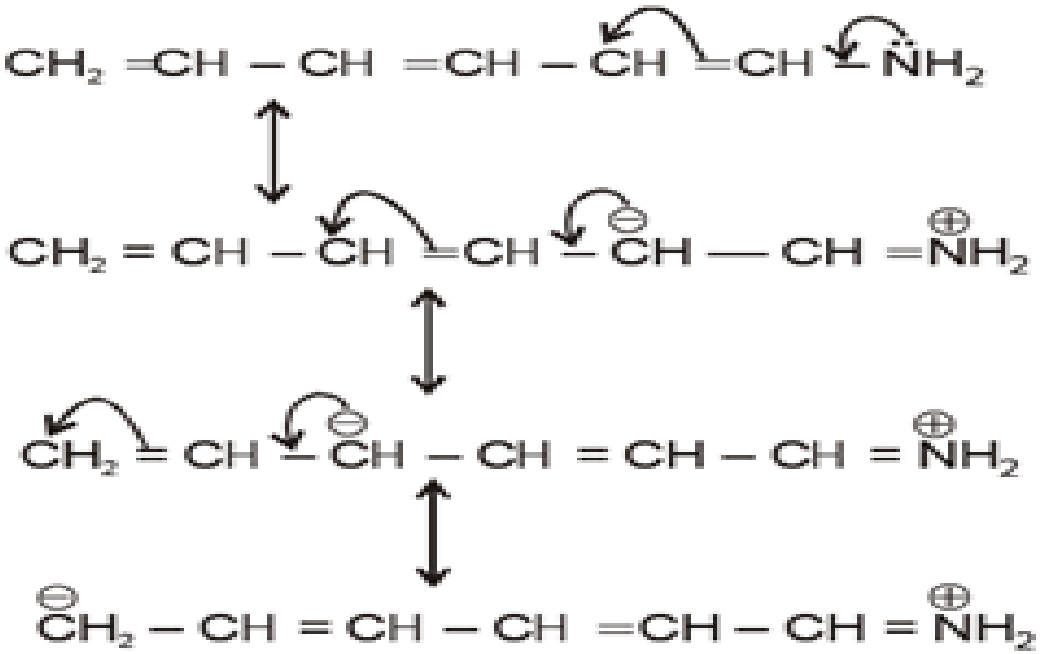
+M EFFECT ORDER :

$-O^- > -NH_2 > -NHR > -OR > -NHCOR > -OCOR > -Ph > -F > -Cl > -Br > -I$

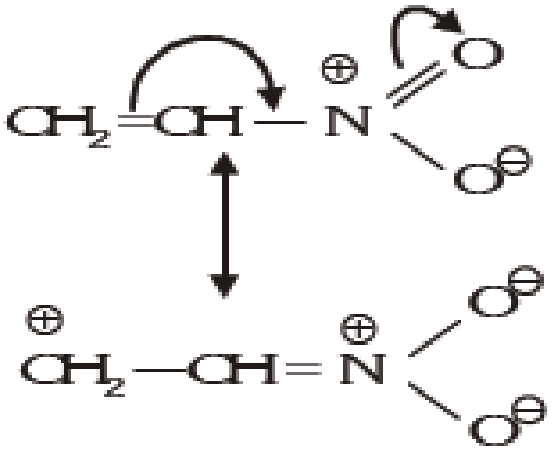
-M EFFECT ORDER :

$-NO_2 > -CN > --S(=O)2-OH > -CHO > -C=O > -COOCOR > -COOR > -COOH > -CONH_2 > -COO^-$

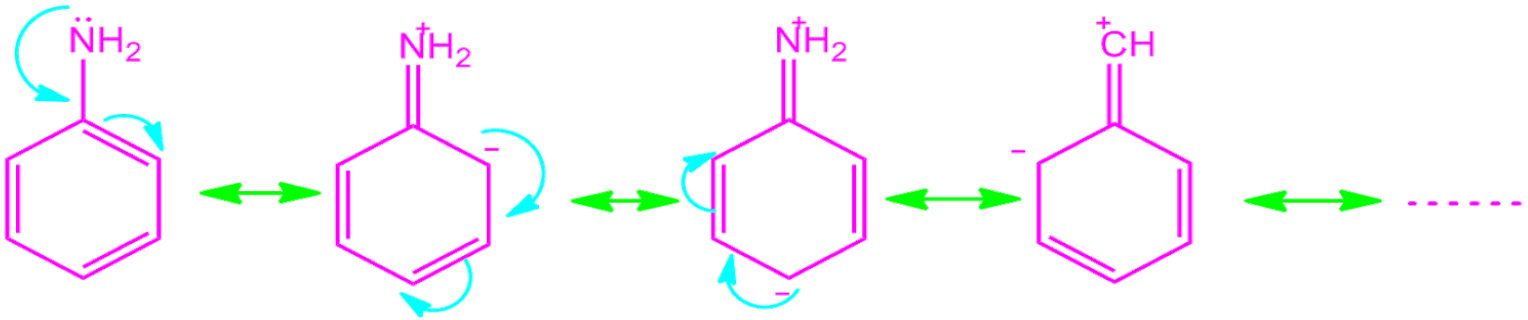
+M effect



-M effect

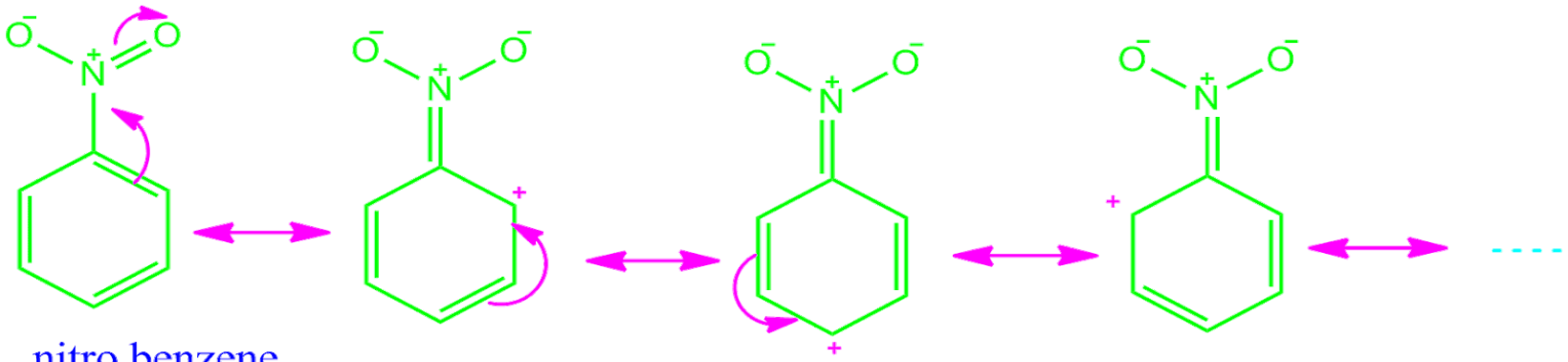


+ M effect :



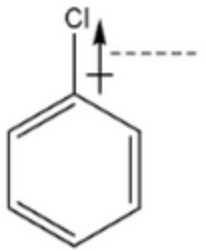
aniline

- M effect :



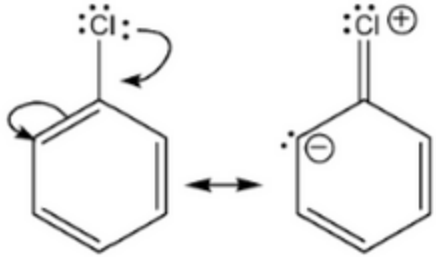
nitro benzene

Inductive Effect vs Resonance Effect



Cl is more electronegative than C, so it inductively withdraws electron density from the ring.

MD

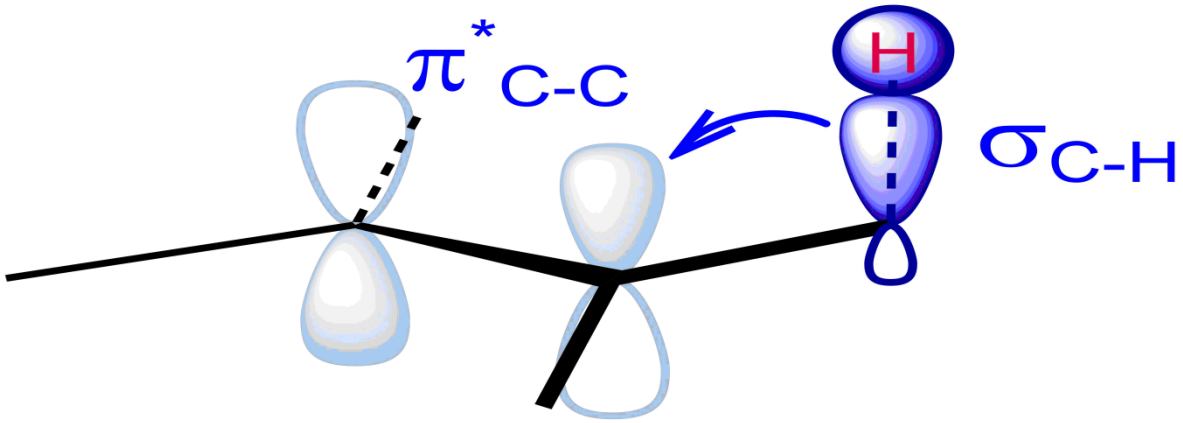


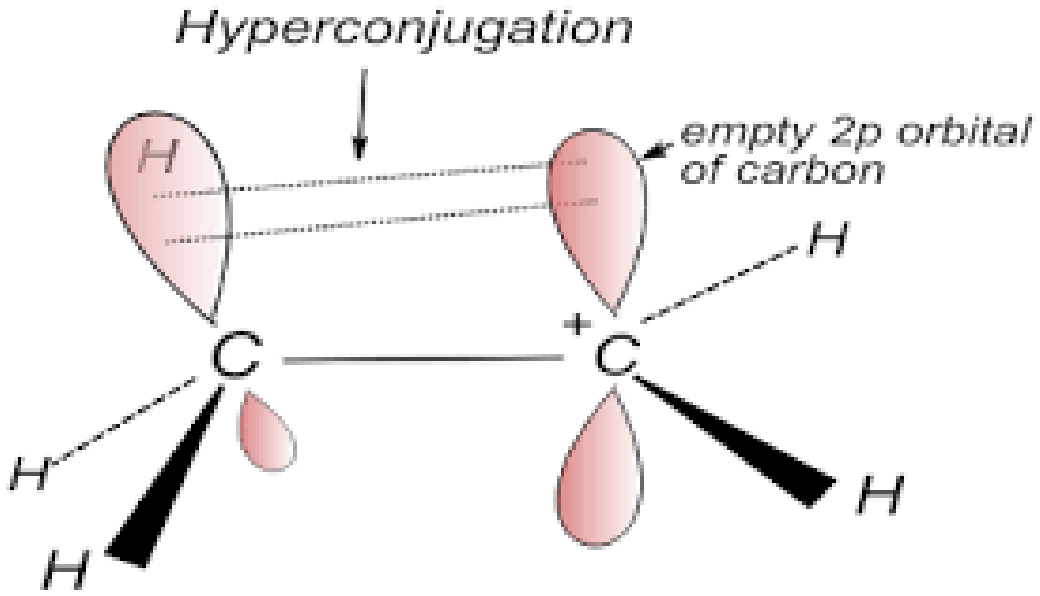
Resonance-donating effects place extra electron density at the *ortho* and *para* positions on the ring.

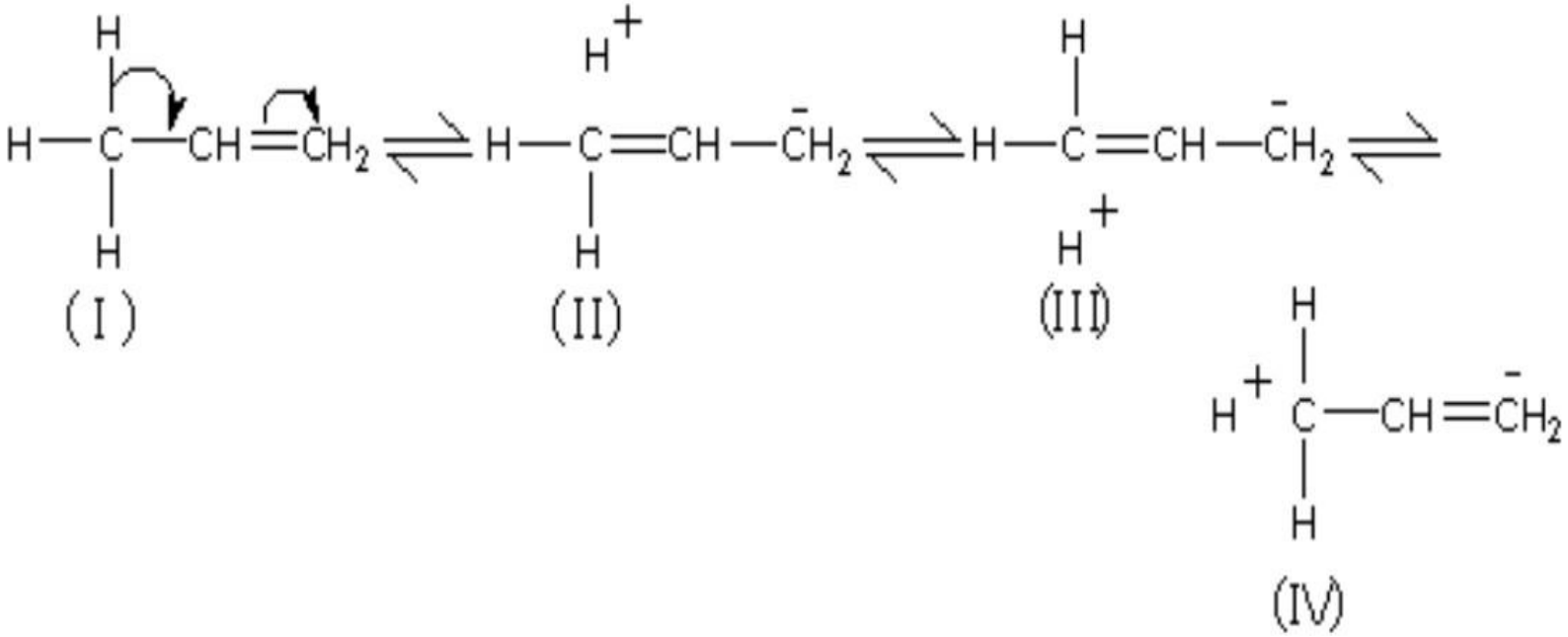
www.majordifferences.com

Hyperconjugation

It the interaction of the electrons in a σ-bond (usually C-H) with an adjacent empty or partially filled p-orbital or a π-orbital




Hyperconjugation
empty 2p orbital
of carbon
H
H
C
C
+
H
H
H


H
H
C
CH
CH2
H+
H
C
CH
CH2
H
C
CH
CH2
H+
H
C
CH
CH2
(I)
(II)
(III)
(IV)

Hyperconjugation: No bond resonance

- The electrons of the sigma bond between C and H are involved in delocalization.
- In structure to the right: No bond between C and H due to migration of the sigma bond. Hence Hyperconjugation is also called as 'NO BOND RESONANCE'.
- This does not indicate that hydrogen is completely detached from the structure, but some degree of ionic character in the C – H bond and some single bond character between carbon – carbon double bond.