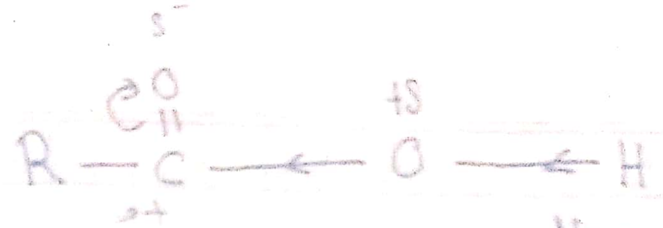
APPLICATION OF INDUCTIVE EFFECT.

(1). Strength of carboxylic acid. An acid is specified that has the tendency to lose the proton. The strength of an acid depend upon the case with which an acid ionises to give proton.



Hence oxygen atom attracts electron towards it from the carbonyl carbon atom in which it pulls electron from the hydroxyl oxygen, with the result the latter assume a +ve charge and this tends to repel the proton.

Question. The acid strength decreases from formic acid to butyric acid.

Answer. As the hydrogen is electron repelling than $-CH_3$, $-C_2H_5$ $-C_3H_7$ groups.

- Formic acid.
- Acetic acid.
- Propionic acid.
- Butyric acid.

(↓ Increasing +I effect; ↓ Decreasing acid strength)

		pKa
Formic acid.	$H-C(=O)-OH$	3.77
Acetic acid.	$CH_3 \rightarrow C(=O) \rightarrow O \rightarrow H$	4.76
Propionic acid.	$C_2H_5 \rightarrow C(=O) \rightarrow O \rightarrow H$	4.88
Butyric acid.	$C_3H_7 \rightarrow C(=O) \rightarrow O \rightarrow H$	4.90

With increase in +I effect removal of hydrogen as proton become more difficult thus decreasing the acid strength.

Question. Halogenated fatty acids are much more stronger than the parent fatty acid.

Because of -I effect due to halogen the strength of halogen attached to the alkyl group

		P^Ka Value
Acetic acid	$CH_3-\overset{\overset{O}{\|\|}}{C}-OH$	4.76.
Iodo acetic acid	$I \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|\|}}{C} \leftarrow O \leftarrow H$	3.12.
Bromo acetic acid	$Br \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|\|}}{C} \leftarrow O \leftarrow H$	2.86.
Chloro acetic acid	$Cl \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|\|}}{C} \leftarrow O \leftarrow H$	2.86.
Dichloro acetic acid	$Cl \leftarrow CH(Cl) \leftarrow \overset{\overset{O}{\|\|}}{C} \leftarrow O \leftarrow H$	1.29.
Trichloro acetic acid	$Cl_3C \leftarrow C \leftarrow O \leftarrow H$	0.65.

Increasing -I effect.

Increasing acid strength.

The cumulative inductive effect of three chlorine atoms in trichloro acetic acid make this substance almost so stronger an acid as hydro chloric acid. The proportionately decrease in acid strength in.

α, β, γ in butyric acid can be visualised on the basis of decrease in Inductive Effect.

(Q) Basic characters of amines (strength of bases).
The basic character of amines is due to the presence of unshared electron pairs on nitrogen atom which accept proton. The readiness with which the lone pairs of electron is available for co-ordination with a proton determine the relative basic strength of amines.

Question:- Due to electron releasing inductive effect of alkyl group the nitrogen atom becomes strongly electronegatively with the result that the lone pairs of electron in amines is more easily available than in ammonia and thus amines are stronger bases than ammonia.
The basis character of amines on the basis of inductive effect is the following order
T > S > P but is found in the following order S > P > T.
This anamoly has been explained on the basis of solvation and consequently stabilization of the conjugate acids of amines by water molecules through the formation of hydrogen bonds. The conjugate acid of tertiary

amine has less capacity to enter in hydrogen bonding as it has only one hydrogen as compared to two or three hydrogens in the conjugate acids of secondary and primary amines respectively.
The reasons for this is believed to be steric factors.

Question. Aniline is a weak base than than the aliphatic amines?

Answer:- In case of aniline the lone pair of electron on nitrogen is delocalised due to resonance and hence is less available than that of the aliphatic amine where the phenomenon of resonance is not possible. The basity of aniline is also further decreased if electro negative group ($-NO_2$) is present. On the other hand if aniline is substituted by an electron repelling (+I) group the basic character increases.

Application of Inductive Effect.

CH_3COOH is a weaker acid than $HCOOH$.
$ClCH_2COOH$ is stronger acid than CH_3COOH.
CH_3NH_2 is stronger base than CH_3 ~~CH_3NH_2~~

(4) - $(CH_3)_2NH$ is a stronger base than CH_3NH_2.

(5) $(CH_3)_3N$ is weaker base than $(CH_3)_2NH$.

(6). C_6H_6 is less reactive than $C_6H_5CH_3$ towards electrophilic substitution reaction.

(7). $C_6H_5NO_2$ is less reactive than C_6H_6.

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