Properties (Physical) :→

i. It has unpleasant smell (In lower member).

ii) Carbon no. C_1 to C_9 of Carboxylic acid are Colourless liquids, higher no. of carboxylic acid are wax like solids having no smell.

iii) Carboxylic acid can form intermolecular hydrogen bond with each other so it's boiling point is comparatively higher than Aldehyde, Ketones, Alcohols, & alkane having same molecular mass.

iv.) Carbon no. C_1 to C_4 of carboxylic acid can form hydrogen bond with water so it is soluble in water. As molecular mass increases a size of alkyl group increases tendency to form hydrogen bond with water decreases so solubility in water decreases. carboxylic acid can dissolve in polar organic solvent also like alcohol.

Chemical properties :→

(A) Reaction of Carboxylic acids are of four types mainly :-

1) Cleavage of O – H bond in Carboxylic acid.
ii) Cleavage of C – OH bond in Carboxylic acid
iii) Reaction involving – COOH group
iv) Substitution reaction in hydrocarbon part.

[A] Reactions involving cleavage of O–H bond:–
During reaction when O–H bond breaks H+ is released which proves acidic character of carboxylic acid.

Acidic character

Carboxylic acid > phenol > H_2O > Alcohol.

Carboxylic acid react with active metal like Na, or alkalis like NaOH or base salt like Na_2CO_3 or $NaHCO_3$.

Comparision
with Metal alcohol can react.
with metal & alkalies phenol can react.
but with Na_2CO_3 & $NaHCO_3$ only carboxylic acid can react to give CO_2 gas.
Hence by the above three reactions alcohol, phenol & carboxylic acid can be identified easily.

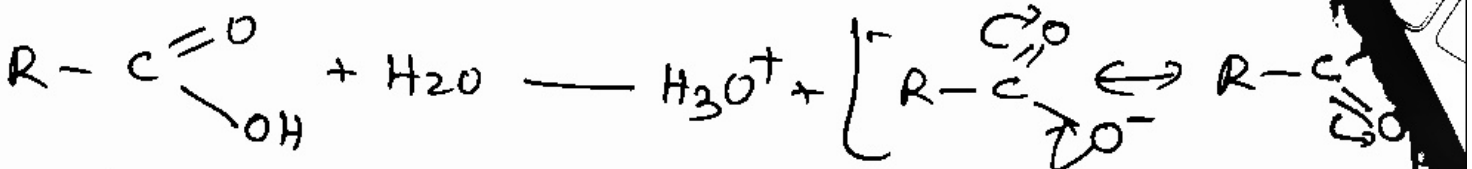
$$2\,R-\overset{O}{\overset{\|}{C}}-OH + 2Na \longrightarrow 2\,R-\overset{O}{\overset{\|}{C}}-ONa + H_2\uparrow$$
(Sod. Carboxylate)

$$R-\overset{O}{\overset{\|}{C}}-OH + NaOH \longrightarrow R-\overset{O}{\overset{\|}{C}}-ONa + H_2O.$$

$$R-\overset{O}{\overset{\|}{C}}-OH + NaHCO_3 \longrightarrow R-\overset{O}{\overset{\|}{C}}-ONa + CO_2\uparrow$$

Note: Carboxylic acid can dissociate in water to give resonance stabilised carboxylate anions & hydronium ion, but carboxylic acid can associate in benzene.

Teacher's Signature : _____



Acidic Strength of Carboxylic acid :→

Carboxylic acids are weak acids, because it liberate less amount of H^+ in water. Acidic strength of Carboxylic acid can be explained by three parameters mainly:

i) Ka value : Ionisation Constant of acid.
ii) pKa : : Ionisation Constant based on $-\log_{10}$.
iii) Inductive effect.

1. Ka value (Ionisation Constant of acid) :→

$$R\text{-}COOH + H_2O \longrightarrow RCOO^- + H_3O^+$$

$$K = \frac{[RCOO^-][H_3O^+]}{[R\text{-}COOH][H_2O]}$$, where K is equilibrium Constant

$$Ka = K \times H_2O$$

$$Ka = \frac{[H_3O^+][RCOO^-]}{[R\text{-}COOH]}$$, Ka ∝ Acidic Strength of Carboxylic acid

More is the value of Ka more is the acidic Strength, but instead of Ka we use pKa value to explain acidic Strength.

ii. pKa value :→

$$pKa = -\log_{10} Ka$$

$$pKa = \log_{10} \frac{1}{Ka}$$

Hence pKa is the reverse form of Ka.

So, as pKa value increases acidic strength of carboxylic acid decreases.

$$pKa \propto \frac{1}{\text{Acidic Strength}}$$

a) Strong acid contain pKa value < 1.
b) Moderate acid strength pKa value is 1 to 5.
c) Weak acids have pKa value 5 to 15
d) Extremely weak acid have pKa value > 15.

Carboxylic acids < Mineral acids.

Carboxylic acid > phenol > H2O > Alcohol.

If we compare the acidic strength of carboxylic acid and phenol, then we observe acidic strength of carboxylic acid is more, although it has only two resonating structures but conjugate base of carboxylic acid i.e carboxylate ion is stabilised by two equivalence resonance structure in which the negative charge is at the more electronegative oxygen atom. In conjugate base of phenol ie phenoxide ion has non equivalent resonance structure in which the negative charge is at less electronegative Carbon atom therefore the resonance in carboxylate ion is more important than resonating structure of phenoxide ion.

Teacher's Signature: