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TOPIC: ASSIGNMENT ON CARBOXYLIC ACIDS

1. The IUPAC names of the following compounds are:
2. HCOOH – Methanoic acid
3. HOOCCH2CH2CH2COOH – Pentan-1,5-dioic acid
4. CH3CH2CH2COOH – Butanoic acid
5. HO2C-CO2H – Ethanedioic acid
6. CH3(CH2)4COOH – Hexanoic acid
7. CH3CH=CHCH2CH2COOH – Hex-4-eneoic acid
8. Physical properties of carboxylic acids include:
9. Physical Appearance:

All simple aliphatic carboxylic acids up to C10 are liquids at room temperature. Most other carboxylic acids are solid at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

1. Boiling Point:

Boiling point increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass.

1. Solubility:

Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water; this largely due to their ability to form hydrogen bonds with water molecules. The water solubility of the acids decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvents.

1. Industrial Preparation of Carboxylic acids:
2. From carbon (II) oxide:

Methanoic acid (Formic acid) is manufactured by adding carbon(II)oxide under pressure to hot aqueous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with tetraoxosulphate (VI) acid (H2SO4).

H2SO4

NaOH

CO HCOONa HCOOH + NaHSO4

1. From Ethanal:

Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganate (II) ethanoate catalyst. Ethanal itself is obtained from ethylene (acetylene).

O2

dil. H2SO4

HC CH CH3CHO CH3COOH

(CH3COO)2Mn

HgSO4

1. Some of the methods of synthetic preparations of carboxylic acids include:
2. Oxidation of Primary Alcohols and Aldehydes:

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidising agents (i.e K2Cr2O7 or KMnO4 in acidic solution).

[O], excess acid

[O]

RCH2OH RCHO RCOOH

K2Cr2O7 or KMnO4

1. Carbonation of Grignard Reagent:

Aliphatic carboxylic acids are obtained by bubbling carbon (IV) oxide into the Grignard reagent after which they are hydrolysed with dilute acid.

(C2H5)2O

H2O

RCH2OH + CO2 RCOOMgBr RCOOH + MgBrOH

dil. acid

R may be 1o, 2o, 3o aliphatic alkyl or aryl radical

In the preparation of benzoic acid, the reagent is added to solid carbon (IV) oxide (dry ice) which also serves as coolant to the reaction mixture.

H2O/H+

(C2H5)2O

C6H5MgBr + CO2 C6H5COOMgBr C6H5COOH + MgBrOH

1. Hydrolysis of Nitriles (Cyanides) or Esters:

H+

RCN + 2H2O RCOOH + NH4+

(R = alkyl or aryl radical)

Example:

H+

C6H5CH2CN + 2H2O  C6H5CH2COOH + NH4+

RCOOR’ RCOOH + R’OH

reflux

H2O/H+

Example:

H2O/H+

CH3CH2COOCH3 CH3CH2COOH + CH3OH

reflux

1. Chemical reactions of carboxylic acids are:
2. Reduction of Primary Alcohols:

(C2H5)2O

4RCOOH + 3LiAlH4  (RCH2O)4AlLi + 2LiAlO2 + 4H2

4H2O

4RCH2OH + Al(OH)3 + LiOH

Example:

LiAlH4

CH3CH2CH2COOH CH3CH2CH2CH2OH

Butanol

Butanoic acid

1. Decarboxylation:
2. Thermal Decarboxylation:

fuse

CH3CH2CH2COONa + NaOH CH3CH2CH3  + Na2CO3

1. Kolbe Synthesis:

electrolysis

2CH3CH2COONa + 2H2O CH3(CH2)2CH3 + CO2 + 2NaOH + H2

Cathode

Anode

aq. CH3OH

1. Esterification:

H+

CH3CH2CH2COOH + CH3CH2CH2OH CH3CH2CH2COOCH2CH2CH3 + H2O

Propylbutanoate