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CHEMISTRY 102

1) Give the IUPAC Names of the following compound

Answers

a) $HCOOH$ ⟶ Methanoic acid

b) $HOOCCH_2CH_2CH_2COOH$ ⟶ pentane-1, 5-dioidoacid).

c) $CH_3CH(CH_2COOH$ ⟶ Butanoic acid

d) HO_2C-CO_2H ⟶ Ethanedioic acid.

e) $CH_3(CH_2)_4COOH$ ⟶ Hexanoic acid.

f) $CH_3CH=CHCH_2CH_2COOH$ ⟶ Hex-4-enoic acid.

2) physical properties of carboxylic acids.

i) Physical Appearance.

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

ii) BOILING POINTS;

Boiling points 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.

iii) SOLUBILITY

lower molecular mass carboxylic acid with up to four carbon atoms in their molecules are soluble in water, this largely aid to their solubility. to form hydrogen bonds with water molecules. This Water ~~molecules~~ solubility of the acids decreases as the relative molecules mass increases because the structure becomes relatively mass hydrogen in nature and hence

covalent. Carboxylic acids are soluble in organic solvents

3) INDUSTRIAL PROPERTIES OF CARBOXYLIC ACIDS

i) From Carbon(II) Oxide

Methanoic acid is manufactured by the carbon(II) oxide under pressure to hot aqueous solutions of sodium hydroxide. The free carboxylic acid is led by careful reagent with to tetraoxosulphate (VI) acid. (H_2SO_4)

$$CO \xrightarrow{NaOH} HCOONa \xrightarrow{H_2SO_4} HCOOH + NaHSO_4$$

ii) From petroleum

Liquid phase air oxidation of C_5-C_7 alkanes, obtainable from petroleum at high temperatures and pressure will give C_5-C_7 carboxylic acids with, methanoic, propanoic and butanoic acid as by products

$$C_5-C_7 \xrightarrow{O_2 / \text{High temperature and pressure}} C_5-C_7 \text{ carboxylic acids}$$

(2) With equations and brief explanation discuss the synthetic preparation of carboxylic acids.

Answer

① Oxidation of primary alcohols and aldehydes.

Oxidation of primary alcohols and aldehydes are to be used to prepare carboxylic acids using the usual oxidizing agents (i.e $K_2Cr_2O_7$ or $KMnO_4$) in acidic solution.

$$RCH_2OH + [O] \xrightarrow{\text{excess acid } KMnO_4} RCHO \xrightarrow{[O]} RCOOH$$

ii) Carbonation of Grignard reagents

Aliphatic carboxylic acids are obtained by bubbli

carbon(iv) oxide into the Grignard reagent and then hydrolyzed with dicate acid.

$RMgBr + CO_2 \xrightarrow{(C_2H_5)_2O} RCOOMgBr \xrightarrow{H_2O\ dil\ acid} RCOOH + MgBrOH$

R may be 1°, 2°, 3° aliphatic alkyl or

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.

$C_6H_5MgBr + CO_2 \xrightarrow{(C_2H_5)_2O} C_6H_5COOMgBr \xrightarrow{H_2O/H^+} C_6H_5COOH + MgBrOH$

ii) Hydrolysis of nitriles (cyanides) or esters

$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+$

(R = alkyl or aryl radical)

$RCOOR' \xrightarrow[reflux]{H_2O/H^+} RCOOH + R'OH$

$C_6H_5CH_2CN + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+$

$CH_3CH_2COOCH_3 \xrightarrow[Hydrolysis]{H_2O/H^+} CH_3CH_2COOH + CH_3OH$

5) With chemical equation only. Outline the reaction, decarboxylation and estarification of carboxylic acid.

Answer

REDUCTION

$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 +$

$\downarrow$

$4RCH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid — Butane

ii) Decarboxylation

$CH_3CH_2CH_2COONa + NaOH \xrightarrow{fuse} CH_3CH_2CH_3 + Na_2CO_3$

Kolbe Synthesis

$2CH_3CH_2COONa + 2H_2O \longrightarrow CH_3(CH_2)CH_3 + (O_2\ gas) + 2NaOH + H_2$

(ii) Esterification.

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xrightleftharpoons{H^+} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$