CHM 102 ASSIGNMENT

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Answers

(1) Iupac names.

- $HCOOH$ - Methanoic acid.
- $HOOCCH_2CH_2CHCOOH$ - Pentan-1, 5-dioic acid.
- $CH_3CH_2CH_2COOH$ - Butanoic acid.
- HO_2C-CO_2H - Ethanedioic acid.
- $CH_3[CH_2]_4COOH$ - Hexanoic acid.
- $CH_3CH-CHCH_2CH_2COOH$ - Hex-4-enoic acid.

(2) Physical properties.

(i) Physical appearance: All sample aliphatic carboxylic acids up to 10 are liquids at room temperature, most are solid at room temp although acetic acid freezes on ice like solid below room temp.

(ii) Boiling points: It increases with increasing relative mass, aromatic acids are crystalline solids have high melting point than aliphatic counterparts or comparable molecular mass.

(3) Two industrial preparation of carboxylic acids.

(i) From carbon(ii) oxide: methanoic acid [formic acid] manufactured by adding CO under pressure to hot $NaOH(aq)$, the carboxylic acid is liberated by careful reaction with H_2SO_4

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

(ii) From ethanal: Ethanoic acid is obtained commercially by the liquid aero-oxidation of 5% solution of ethanal to ethanoic acid using manganese(II) ethanoate catalyst, ethanal is obtained from ethylene.

$$HC\equiv CH \xrightarrow{dil\ H_2SO_4/HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$$

(4)

(i) Oxidation of primary alcohol & aldehydes: It can be used to prepare carboxylic acid using the usual oxidizing agents [i.e $K_2Cr_2O_7$ or $KMnO_4$] in acidic solution $RCH_2OH \xrightarrow{\text{excess acid / } KMnO_4} RCHO \xrightarrow{[O]} RCOOH$

(ii) Carboxylation of grignard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon(IV)oxide into the grignard reagents and then hydrolyzed with dilute acid.

$R MgBr + CO_2 \xrightarrow{(C_2H_5)_2O} RCOOMgBr \xrightarrow{H_2O/\text{dil. acid}} RCOOH + MgBrOH$

(R may be 1°, 2°, 3° aliphatic alkyl or ethyl radical

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

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

(iii) Hydrolysis of nitrile [cyanides] or ester

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

[R = alkyl or acyl radical]

$RCOOR \xrightarrow{H_2O / H^+ \text{ reflux}} RCOOH + ROH$

$C_2H_5CH_2CN + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+$

$CH_3CH_2COOCH_3 \xrightarrow{H_2O/H^+ \text{ reflux}} CH_3CH_2COOH$

(5)

- Reduction of primary alcohol

$4RCOOH + 3NaAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + 4H_2$

$\downarrow + 4H_2O$

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

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid. Butanol

- Decarboxylation

Thermal decarboxylation

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

Kolbe Synthesis

$2(H_3CH_2COONa + 2H_2O \xrightarrow[\text{electrolysis}]{NaOH} aq(CH_3OH) CH_3[CH_2]_2CH_3 + 2NaOH + H_2$ [cathode

-Esterification

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