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DEPARTMENT: MEDICINE AND SURGERY

CHM 102 ASSIGNMENT

1. (a) HCOOH Methanoic acid

(b) HOOCCH2CH2CH2COOH Pentan-1, 5-dioic acid

(c) CH3CH2CH2COOH Butanoic acid

(d) HO2C-CO2H Ethanedioic acid

(e) CH3 (CH2)4COOH Hexanoic acid

(f) CH3CH=CHCH2CH2COOH Hex-4-eneoic acid

1. (i) Physical appearances: All simple aliphatic carboxylic acids up to C10 are liquids at room temperature. 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.

(ii) Boiling points: 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.

(iii) Solubility: Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water; this is 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. (a) 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 H2SO4, a strong acid.

CO NaOH HCOONa H2SO4 HCOOH + NaHSO4

(b) From ethanal

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

HC CH dil. H2SO4/HgSO4 CH3CHO O2/ (CH3COO) 2 Mn CH3COOH

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

RCH2OH [O], excess acid/KMnO4 RCHO [O] RCOOH

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

RMgBr + CO2 (C2H5)2O RCOOMgBr H2O/ dil. acid RCOOH + MgBrOH

R may be 1, 2, 3 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.

C6H5MgBr + CO2 (C2H5)2O C6H5COOMgBr H2O/H+ C6H5COOH + MgBrOH

(iii) Hydrolysis of nitriles (cyanides) or esters

RCN + 2H2O H+ RCOOH + NH4­+

(R=alkyl or aryl radical)

RCOOR’ H2O/H+ reflux RCOOH + R’OH

C6H5CH2CN + 2H2O H+ C6H5CH2COOH + NH4+

CH3CH2COOCH3 H2O/H+ reflux CH3CH2COOH + CH3OH

1. (a) Reduction to primary alcohol

4RCOOH + 3LiAlH4 (C2H5)2O (RCH2O) 4AlLi + 2LiAlO2 + 4H2

4H2O

4RCH2OH + Al (OH) 3 + LiOH

CH3CH2CH2COOH LiAlH4 CH3CH2CH2CH2OH

Butanoic acid Butanol

1. Decarboxylation

*Thermal decarboxylation*

CH3CH2CH2COONa + NaOH fuse CH3CH2CH3 + Na2CO3

*Kolbe synthesi*s

2CH3CH2COONa + 2H2O electrolysis/aq. CH3OH CH3 (CH2)2CH3 +CO2 (anode) + 2NaOH + H2 (cathode)

1. Esterification

CH3CH2CH2COOH + CH3CH2CH2OH H+ CH3CH2CH2COOCH2CH2CH3 + H2O