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CHM102 ASSIGNMENT.

(1.) $HCOOH$ → Methanoic acid
$HOOCCH_2CH_2CH_2COOH$ → 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.) (a) Physical appearance: All simple aliphatic carboxylic acids up to C_{10} 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.

(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 ~~compounds~~ counterparts of comparative relative molecular mass.

(iii) 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.

(3.) (i) From carbon (II) oxide.
(ii) From ethanol.

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

$RCH_2OH \xrightarrow{[O],\ excess\ acid/KMnO_4} RCHO \xrightarrow{[O]} RCOOH$

(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 -

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

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

(iii) Hydrolysis of nitriles (cyanides) or esters.

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

R → alkyl or aryl radical.

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

Examples:

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

$CH_3CH_2COOCH_3 \xrightarrow{H_2O/H^+\ reflux} CH_3CH_2COOH + CH_3OH$

(5.) Reduction of carboxylic acid:

$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} CR(CH_2O)_4AlLi + 2LiAlO_2 + 4H_2 \xrightarrow{4H_2O} HRCH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

butanoic acid — butanol.

Decarboxylation of carboxylic acid:

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

Kolbe Synthesis.

$2CH_3CH_2COONa + 2H_2O \xrightarrow{electrolysis/aq.\ CH_3OH} CH_3(CH_2)_2CH_3 + CO_2(anode) + 2NaOH + H_2(cathode)$

Esterification of carboxylic acid:

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

butanoic acid + propanol ⇌ propyl butanoate.