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Answer

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) Physical appearances: All simple aliphatic carboxylic acid 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
Boiling points: Boiling points increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have highest melting points than their aliphatic counterparts of comparable relative molecular mass
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) From ethanol: Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganese (II) ethanoate catalyst. Ethanal itself is obtained from ethylene.

$HC \equiv CH$ dil H_2SO_4/$HgSO_4$ $\rightarrow$ CH_3CHO $\xrightarrow{[O]}$ CH_3COOH

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 (H_2SO_4)

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

4) Oxidation of primary alcohols and aldehydes: Oxidation of primary alcohols and aldehydes can lead to carboxylic acid using the usual oxidizing agents ($K_2Cr_2O_7$ or $KMnO_4$) in acidic solution

$RCH_2OH \xrightarrow{[O]} RCHO \xrightarrow{[O]} RCOOH$

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

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

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

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

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

7)

8) Hydrolysis of nitriles (cyanides) or esters

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

(R = alkyl or aryl radical)

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

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

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

5) Reduction →

$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + 4H_2$

$\downarrow + 4H_2O$

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

$CH_3CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid. Butan-1-ol

2) Decarboxylation

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

Kolbe synthesis

$2CH_3CH_2COONa + 2H_2O \xrightarrow[\text{electrolysis}]{CH_3OH} CH_3(CH_2)_2CH_3 + CO_2 + 2NaOH + H_2$ (at cathode)

3) Esterification

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