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1a. $HCOOH$ - Methanoic acid
b. $HOOCCH_2CH_2CH_2COOH$ - Pentan-1,5-dioic acid
c. $CH_3CH_2CH_2COOH$ - 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

2a. 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 room temperature.

b. BOILING POINTS:
It 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.

c. SOLUBILITY:
Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water (due to their ability to form hydrogen bonds with water molecules). The water solubility of the acids decrease as the relative molecular mass increase because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvents.

3a. From Carbon (II) oxide:

Methanoic acid (formic acid) is manufactured by adding carbon (II) oxide under pressure to hot aqueous solution of solution hydroxide. The free carboxylic acid is liberated by careful reaction with ~~tetraoxosulphate~~ (VI) acid ($H_2SO_4$).

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

b. From Ethanal:

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

4a. Oxidation of Primary Alcohols and Aldehydes (Synthetic Preparation of Carboxylic Acid):

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

$$RCH_2OH \xrightarrow{[O],\ \text{excess acid}/KMNO_4} RCHO \xrightarrow{[O]} RCOOH$$

5a. Reduction:

$$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLr + 2LiAlO_2 + 4H_2$$

$$\downarrow 4H_2O$$

$$4RCH_2OH + Al(OH_3) + LiOH$$

$$\underset{\text{Butanoic acid}}{CH_3CH_2CH_2COOH} \xrightarrow{LiAlH_4} \underset{\text{Butanol}}{CH_3CH_2CH_2CH_2OH}$$

b. Isterification:

$$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \overset{H^+}{\rightleftharpoons} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$$

c. Decarboxylation:

Thermal decarboxylation:

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

Kolbe synthesis:

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

4b 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.

In the preparation of benzoic acid, the reagent is added to solid carbon (iv) oxide (dry ice) which also serves as codant to the reaction mixture.

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

c. Hydrolysis of Nitriles (cyanides) or Esters

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

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

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

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