NAME: ODEKWO FAITH OGHENEKOME
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Assignment Solution

1. Give the IUPAC names of the following compounds.

a. $HCOOH$
Methanoic acid

b. $HOOCCH_2CH_2CH_2COOH$
Pentanoic, 5-dioic acid

c $CH_3CH_2CH_2COOH$
Butanoic acid

d HO_2C-CO_2H
Ethane dioic acid

e $CH_3(CH_2)_4COOH$
Hexanoic acid

f $CH_3CH=CHCH_2CH_2COOH$
Hex-4-eneoic acid.

2a Physical appearance
All simple aliphatic carboxylic acids upt C_{10} are liqui at room temperature. Most other carboxylic acids are solid at room temperature.

b. Boiling Point
The boiling point increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solid 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. This is largely due to their ability to form hydrogen bonds with water molecules.

3. a. From Carbon (II) oxide
Methanoic (formic acid) is manufactured by adding carbon(II) oxide under pressure to hot aqueous solution of sodium hydroxide.

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

b. From Ethanal

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

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

$$RCH_2OH \xrightarrow[K_2Cr_2O_7 \text{ or } KMnO_4]{[O],\ \text{excess acid}} RCHO \xrightarrow{[O]} RCOOH$$

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

$$RMgBr + CO_2 \xrightarrow{(C_2H_5)_2O} RCOOMgBr \xrightarrow[\text{dil. acid}]{H_2O} RCOOH + MgBrOH$$
R may be 1°, 2°, 3° aliphatic alkyl or aryl radical.

5 $CH_3CH_2CH_2CO_2H \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

5 $CH_3CH_2CH=CHCO_2H \xrightarrow{LiAlH_4} CH_3CH_2CH=CHCH_2OH$

Pent-2-enoic acid — Pent-2-enol

Reduction

5. $CH_3CH_2CH=CHCO_2H \xrightarrow{LiAlH_4} CH_3CH_2CH=CHCH_2OH$

Pent-2-enoic acid. — Pent-2-enol

Decarboxylation

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

$NO_2-CH_2CH_2CO_2H \xrightarrow{150^\circ C} CH_3CH_2NO_2 + CO_2$

3-Nitropropanoic acid — Nitroethane

Esterification

$CH_3CH_2CH_2CO_2H + CH_3CH_2CH_2OH \rightleftharpoons CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$

Propylbutanoate.