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COMPUTER ENGINEERING (19/ENG02/054)
CHM 102 (CHEMISTRY ASSIGNMENT)
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1) Name the following Compounds
- $HCOOH$ → 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-eneoic acid

2 PHYSICAL PROPERTIES OF CARBOXYLIC ACIDS

(i) PHYSICAL APPEARANCE
All simple aliphatic carboxylic acids up to $C_{10}$ are liquids at room temperature. Most other carboxylic acids are solids 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 points 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 carbo atoms in their molecules are soluble in water; this largely due to their ability to form hydrogen bonds with wat

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 INDUSTRIAL PREPARATION OF CARBOXYLIC ACIDS

### (I) 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 ($H_2SO_4$)

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

### (II) 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 itself is obtained from ethylene.

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

## 4) SYNTHETIC PREPARATION OF CARBOXYLIC

### (I) OXIDIZATION OF PRIMARY ALCOHOLS/ALDEHYDES

* Chemistry of the reactions: Primary alcohols and aldehydes are normally oxidised to carboxylic acids using potassium dichromate (VI) solution in the presence of dilute sulphuric acid. During the reaction, the potassium dichromate (VI) solution turns from orange to green.

The potassium dichromate (VI) can just as well be replaced with sodium dichromate (VI). Because what matters is the dichromate (VI) ion, all the equations and colour changes will be identical.

Primary alcohols are oxidised to carboxylic acids in two stages
- FIRST: to aldehyde and then,
- SECOND: to the acid

We often use simplified versions of these equations using "[O]" to represent oxygen from the oxidising agent.
The formation of the aldehyde is shown by the simplified equation:-

$$RCH_2OH + [O] \longrightarrow R-C(=O)-H + H_2O$$

↳ This means oxygen from an oxidising agent.

"R" is a hydrogen atom or a hydrocarbon group such as alkyl group.
The aldehyde is then oxidised further to give the carboxylic acid:

$$R-C(=O)-H + [O] \longrightarrow R-C(=O)-OH$$

if you start with an aldehyde, you are obviously just doing the second stage. Starting from the primary alcohol, you could combine these into one single equation to give:

$$RCH_2OH + 2[O] \longrightarrow RCOOH + H_2O$$

* For example, if we were converting ethanol into ethanoic acid the simplified equation would be:

$$CH_3CH_2OH + 2[O] \longrightarrow CH_3COOH + H_2O$$

5(i) Reduction of carboxylic acid to primary alcohol.

$$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O_4)_4AlLi + 2LiAlO_2 + 4H$$

$$\downarrow H_2O$$

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

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

(ii) Decarboxylation

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

(iii) Esterification

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