4.5.3 Carboxylic derivatives and condensation links

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS condensation

Objective

Predict products while retaining the carbonyl carbon and balancing by-products. Questions and marking guidance are original.

1 Key knowledge and worked examples

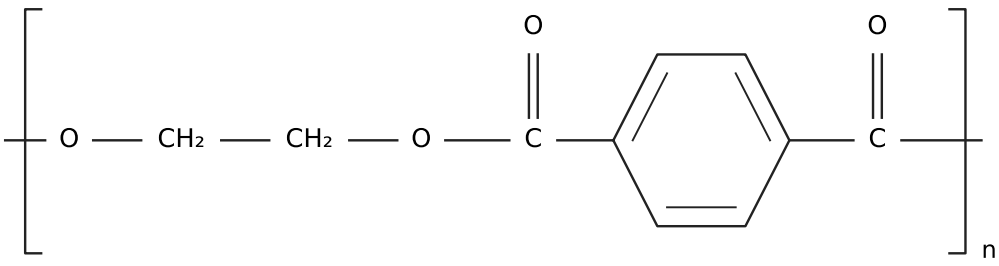
Carboxylic acids react with bases/carbonates to form salts; carbonate releases CO_2. $LiAlH_4$ in dry ether reduces RCOOH to RCH_2OH after work-up. PCl_5 gives RCOCl + $POCl_3$ + HCl.

■ Worked reaction choice

$CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$ uses heat and an acid catalyst. The ester is ethyl ethanoate. Hot aqueous NaOH hydrolyses it to sodium ethanoate and ethanol; do not write a free acid as the immediate alkaline product.

Acyl chlorides react readily with water, alcohols and amines. $CH_3COCl + 2NH_3 \rightarrow CH_3CONH_2 + NH_4Cl$: one ammonia makes the amide, another accepts HCl. A diacid/diol condensation makes a polyester with –CO–O– links and water. The repeat unit keeps both monomer skeletons and open bonds through brackets.

Terylene: completed repeat unit with para benzene links



From ethane-1,2-diol and benzene-1,4-dicarboxylic acid; ester links form by condensation.

2 Practice

2.1 Write a balanced equation for ethanoic acid with sodium carbonate. [3]

2.2 Name the ester made from propanoic acid and methanol, with reagent conditions. [2]

2.3 Write products of ethanoyl chloride with water and with ethanol. [2]

3 Exam-style questions

3.1 Write the overall equation for ethanoyl chloride with excess methylamine. Explain why two methylamine molecules appear. [4]

3.2 Compare acid and alkaline hydrolysis of methyl propanoate. Name both organic products in each case and explain why the alkaline process is driven strongly toward products. [4]

3.3 Draw one terylene repeat unit from ethane-1,2-diol and benzene-1,4-dicarboxylic acid. Show brackets and open bonds. [4]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$.

2.2 Methyl propanoate; heat with an acid catalyst.

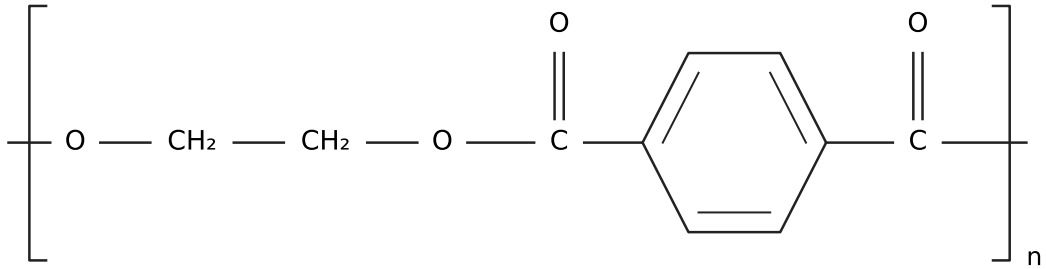
2.3 $CH_3COOH + HCl$; $CH_3COOCH_2CH_3 + HCl$.

3.1 $CH_3COCl + 2CH_3NH_2 \rightarrow CH_3CONHCH_3 + CH_3NH_3Cl$. One amine forms the amide; the other accepts HCl.

3.2 Acid: propanoic acid and methanol, reversible. Alkali: propanoate salt and methanol; formation of carboxylate removes the free acid from the esterification equilibrium and drives the process.

3.3

Terylene: completed repeat unit with para benzene links



From ethane-1,2-diol and benzene-1,4-dicarboxylic acid; ester links form by condensation.

B1 diol skeleton; B1 para aromatic skeleton; B1 correct ester links/carbonyls; B1 brackets with open bonds and n.