18.1 Carboxylic acids

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS esterification • neutralisation • reflux • nitrile • alcohol

Objective

Build the skills to answer exam questions on **carboxylic acids** – making them, and their reactions as **acids** and to change the functional group.

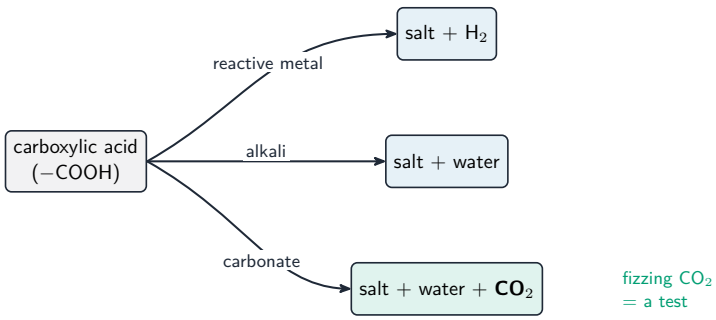
You must be able to:

- recall how carboxylic acids are made (oxidation, hydrolysis of nitriles/esters)
- describe the reactions with metals, alkalis and carbonates
- describe esterification and reduction by $LiAlH_4$

1 Key knowledge and worked examples

■ Making and reacting carboxylic acids

A **carboxylic acid** has the –COOH group (a weak acid). Made by: oxidising a primary alcohol/aldehyde (reflux); hydrolysing a nitrile or ester then acidifying.



Acid reactions: with a metal → salt + H_2; with an alkali → salt + water; with a carbonate → salt + water + CO_2 (the fizz is a test)

$$CH_3COOH + HOC_2H_5 \rightleftharpoons CH_3CO\,O\,C_2H_5 + H_2O$$

the –OH (acid) and –H (alcohol) leave as water; the C–O–C ester link forms

(concentrated H_2SO_4 catalyst; reversible)

Carboxylic acids form esters with alcohols

Two reactions change the functional group: **esterification** with an alcohol (conc. H_2SO_4) → ester; **reduction** by $LiAlH_4$ → primary alcohol.

2 Practice

2.1 Write the equation for ethanoic acid reacting with sodium carbonate. [1]

2.2 State a chemical test, with result, that shows a compound is a carboxylic acid. [2]

3 Exam-style questions

3.1 Which reagent reduces a carboxylic acid to a primary alcohol? [1]

☐ **A** $NaBH_4$
B $LiAlH_4$
C acidified $K_2Cr_2O_7$
D concentrated H_2SO_4

3.2 Ethanoic acid reacts with magnesium to give: [1]

☐ **A** an ester and water
B a salt and hydrogen
C a salt, water and CO_2
D no reaction

3.3 (a) Write the equation for the reaction of ethanoic acid with sodium hydroxide and name the type of reaction. [2]

(b) State the reagents and conditions to make ethanoic acid from ethanol. [2]

3.4 Explain why carboxylic acids fizz with a carbonate but alcohols do not. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$

2.2

- add a carbonate (e.g. sodium carbonate); effervescence / fizzing of CO_2 is seen

3.1 B

- $LiAlH_4$ reduces a carboxylic acid to a primary alcohol

3.2 B

- A reactive metal gives a salt and hydrogen

3.3

(a)

- $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$; neutralisation

(b)

- acidified $K_2Cr_2O_7$ (or $KMnO_4$); heat under reflux

3.4

- carboxylic acids are acidic – they release H^+ which reacts with the carbonate to give CO_2; alcohols are not acidic enough to react with a carbonate