

18.1 Carboxylic acids

Name: _____ Class: _____ Date: _____

Total: 11 marks

Objective

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

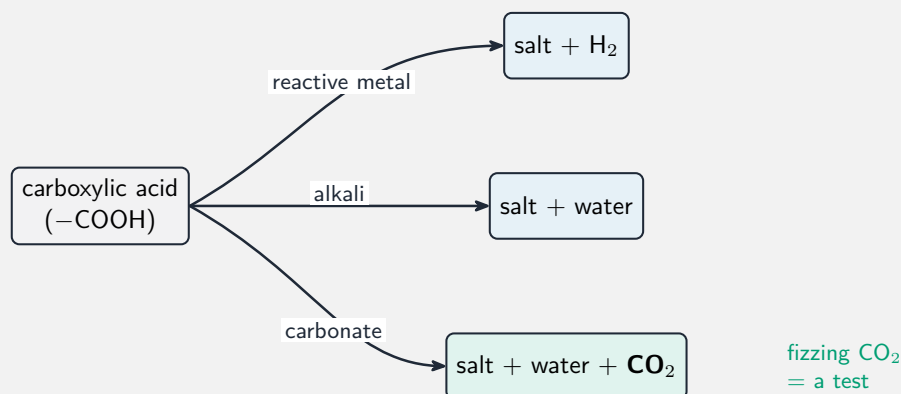
You must be able to:

- recall how carboxylic acids are made (oxidation, hydrolysis of nitriles/esters)
- describe the reactions with metals, alkalis and carbonates
- describe esterification and reduction by LiAlH₄

1 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 $\rightarrow$ salt + H ; with an alkali $\rightarrow$ salt + water; with a carbonate $\rightarrow$ salt + water + CO (the fizz is a test)



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) $\rightarrow$ ester; **reduction** by $\text{LiAlH}_4 \rightarrow$ 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 $\text{K}_2\text{Cr}_2\text{O}_7$
 - **D** concentrated H_2SO_4
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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
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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]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **18.1 Carboxylic acids** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/11 N25 —Q34 (carboxylic acids)
- 9701/12 N25 —Q33 (acid reactions)
- 9701/12 N25 —Q37 (preparation)

Solutions

2.1 $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$.

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) $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$; neutralisation.

(b) acidified $\text{K}_2\text{Cr}_2\text{O}_7$ (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.