

11.7 Carboxylic acids

Name: _____ Class: _____ Date: _____

Total: 21 marks

KEY WORDS ester 酯 • ethanoic acid 乙酸 • carboxylic acids 羧酸 • carbonates 碳酸盐
• oxidation 氧化

Objective

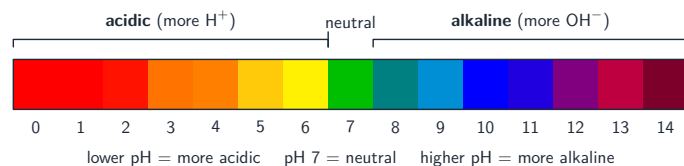
Build the skills to answer exam questions on **carboxylic acids** 羧酸 — the -COOH group, the reactions of **ethanoic acid** 乙酸, making it by **oxidation** 氧化 of ethanol, and **esters** 酯.

You must be able to:

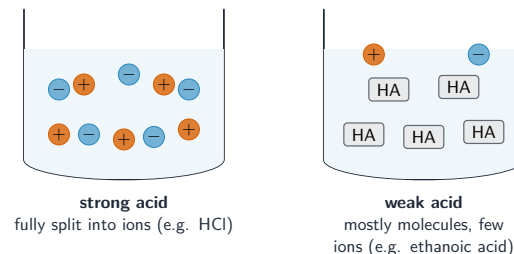
- give the reactions of carboxylic acids (with metals, bases, carbonates)
- describe making ethanoic acid by oxidising ethanol
- describe the formation of an ester

1 Worked examples

■ Reactions of ethanoic acid



Carboxylic acids contain -COOH and behave as (weak) acids



Carboxylic acids are weak acids

- – metal $\rightarrow$ ethanoate salt + hydrogen.
- – base $\rightarrow$ salt + water; + carbonate $\rightarrow$ salt + water + CO_2 .
- **made by:** oxidising ethanol (acidified KMnO_4 , or bacteria $\rightarrow$ vinegar).
- – alcohol (acid catalyst) $\rightarrow$ an **ester**.

2 Practice

2.1 State the functional group in a carboxylic acid. [1]

2.2 Name the type of compound formed when a carboxylic acid reacts with an alcohol. [1]

3 Exam-style questions

3.1 Ethanoic acid reacts with a carbonate to give a salt, water and: [1]

- **A** hydrogen
- **B** oxygen
- **C** carbon dioxide
- **D** chlorine

3.2 Ethanoic acid can be made by oxidising ethanol.

(a) Name a reagent that oxidises ethanol to ethanoic acid. [1]

(b) Name the everyday product made when ethanol is oxidised by bacteria. [1]

3.3 Magnesium reacts with ethanoic acid. Name the two products. [2]

3.4 Ethanoic acid, CH_3COOH , is a weak acid.

(a) Draw the displayed formula of ethanoic acid and circle the functional group, naming it. [3]

(b) Give the observation and name the products for ethanoic acid reacting with (i) magnesium, (ii) sodium carbonate. Write a balanced equation for (ii). [5]

(c) Ethanoic acid is warmed with ethanol and a little concentrated sulfuric acid. Name the type of reaction, name the organic product, and state what the sulfuric acid does. [3]

(d) Explain why ethanoic acid is described as a *weak* acid, and state how its pH compares with hydrochloric acid of the same concentration. [3]

Solutions

2.1 -COOH (the carboxyl group).

2.2 an ester.

3.1 C. Acid + carbonate $\rightarrow$ salt + water + carbon dioxide.

3.2 (a) acidified potassium manganate(VII).
(b) vinegar.

3.3 magnesium ethanoate; hydrogen.

3.4 (a) CH_3 joined to a carbon carrying a double-bonded O and an -O-H , with every bond shown; the circled -COOH is the **carboxyl** group.

(b) (i) Effervescence; the magnesium disappears and hydrogen is given off, leaving magnesium ethanoate. (ii) Effervescence, and the gas turns limewater milky — carbon dioxide;
 $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$.

(c) **Esterification**; the product is **ethyl ethanoate**, which has a sweet fruity smell; the sulfuric acid is a catalyst.

(d) A weak acid only **partly** ionises in water, so a solution of it contains far fewer hydrogen ions than the same concentration of a strong acid; its pH is therefore **higher** — around 3 to 4, compared with about 1 for hydrochloric acid.