

Carboxylic acids

4.7.2.4 · Organic chemistry · revision notes

Carboxylic acids: the -COOH functional group, the first four acids, their reactions with carbonates, in water and with alcohols to make esters. GCSE Chemistry only. Expect naming, observations, word equations and ester questions.

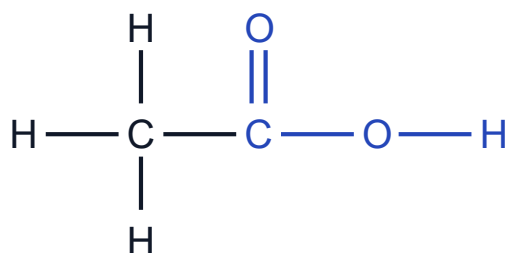
Key facts

- Functional group of carboxylic acids: -COOH
- Carboxylic acid + carbonate $\rightarrow$ salt + water + carbon dioxide (fizzing)
- Carboxylic acid + alcohol $\rightarrow$ ester + water (acid catalyst)
- Ester group: -COO-
- Methanoic HCOOH , ethanoic CH_3COOH , propanoic $\text{C}_2\text{H}_5\text{COOH}$, butanoic $\text{C}_3\text{H}_7\text{COOH}$
- Salts end in -oate, e.g. sodium ethanoate
- Ethanoic acid + ethanol $\rightarrow$ ethyl ethanoate + water

Notes

The carboxylic acids

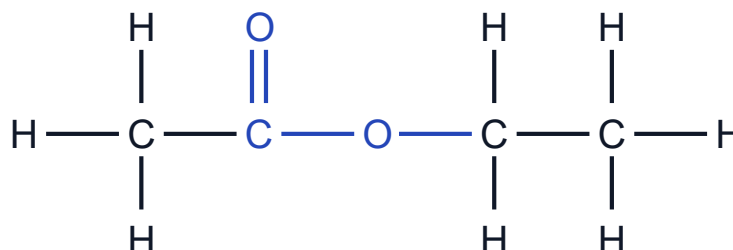
- Carboxylic acids contain the -COOH functional group.
- The first four: **methanoic acid** HCOOH , **ethanoic acid** CH_3COOH , **propanoic acid** $\text{CH}_3\text{CH}_2\text{COOH}$ and **butanoic acid** $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$.
- The carbon atom in -COOH counts in the name: ethanoic acid has two carbon atoms in total.
- Ethanoic acid:



- Vinegar is a dilute solution of ethanoic acid.

Reactions

- **With carbonates:** fizzing, as **carbon dioxide** is given off (it turns limewater milky). A salt and water also form: ethanoic acid + sodium carbonate → sodium ethanoate + water + carbon dioxide.
- The salts end in **-oate**: methanoate, ethanoate, propanoate, butanoate.
- **In water:** they dissolve to form acidic solutions (pH below 7).
- **With alcohols:** with an acid catalyst (e.g. concentrated sulfuric acid), they react to form an **ester** and water: ethanoic acid + ethanol → ethyl ethanoate + water.
- Esters contain the -COO- group. Ethyl ethanoate is the only ester you need to name.



Ethyl ethanoate, $\text{CH}_3\text{COOCH}_2\text{CH}_3$. The ester group -COO- is in blue.

- You do not need balanced equations for these reactions: word equations are enough.

How to answer each type of question

Reaction with a carbonate: observations and products

2 to 3 marks

Grade 5

1. Name the salt: metal name + acid stem + '-oate', e.g. potassium propanoate.
2. The other products are water and carbon dioxide.
3. Observation: fizzing or bubbles; the gas turns limewater milky.

Example. Propanoic acid is added to calcium carbonate.

(a) Give **one** observation.

(b) Complete the word equation.

propanoic acid + calcium carbonate → _____ + water + _____

Model answer. (a) Fizzing / bubbles / the solid disappears (1)

(b) Calcium propanoate (1); carbon dioxide (1)

Esters: the reactants, products and catalyst

1 to 4 marks

Grade 5

1. Carboxylic acid + alcohol $\rightarrow$ ester + water, with an acid catalyst.
2. Ethanol and ethanoic acid make ethyl ethanoate.
3. Name the catalyst: an acid, e.g. concentrated sulfuric acid.

Example. Ethyl ethanoate is used as a solvent in some nail varnish removers.

- (a) Name the alcohol and the carboxylic acid used to make ethyl ethanoate.
- (b) Name the other product of the reaction and the type of catalyst used.

Model answer. (a) Ethanol (1) and ethanoic acid (1)

(b) Water (1); an acid catalyst, e.g. sulfuric acid (1)

Don't lose marks

- ✗ Forgetting to count the carbon in -COOH : CH_3COOH is ethanoic acid (2 carbon atoms), not methanoic acid.
- ✗ Saying carbonates give hydrogen. Carbonates give carbon dioxide; hydrogen comes from reactions with metals.
- ✗ Naming the salt wrongly, e.g. 'sodium ethanol' or 'sodium ethanoic'. It is sodium ethanoate.
- ✗ Leaving out the acid catalyst or the water when describing how an ester is made.

More tips

Memory tricks

- Acid + carbonate: fizzing means carbon dioxide. Test it with limewater.
- Ester names: the alcohol part comes first and ends in '-yl'; the acid part comes second and ends in '-oate'. Ethanol + ethanoic acid $\rightarrow$ ethyl ethanoate.
- '-oic acid' is the carboxylic acid; '-oate' is its salt or ester.

Exam technique

- Balanced equations are not needed for carboxylic acid reactions; give clear word equations with correct names.
- For carbonate reactions, give an observation (fizzing, solid disappears) as well as the name of the gas.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Name the functional group of carboxylic acids

The -COOH group.

Grade 4

Name the first four carboxylic acids

Methanoic, ethanoic, propanoic and butanoic acid; ethanoic acid is CH_3COOH .

Grade 5

Describe the reaction with carbonates

Fizzing as carbon dioxide is given off; a salt and water also form, e.g. sodium ethanoate.

Describe how an ester is made

Carboxylic acid + alcohol, with an acid catalyst, gives an ester and water: ethanoic acid + ethanol → ethyl ethanoate + water.

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