

Taking it Further: Carboxylic Acids

Answer the questions below.

1. State the two methods of producing ethanol.

Through fermentation or by hydration of ethene.

2. Name the functional group found in alcohols.

Hydroxyl group (OH)

3. Describe the conditions needed for the hydration of ethene.

A high temperature (300 °C), a catalyst (phosphoric acid), and 60-70 atm of pressure

4. State the general formula of the alkanes.

C_nH_{2n+2}

5. State the pH range of an acid.

pH 1-7



Taking it Further: Carboxylic Acids

Do Now:

1. State the two methods of producing ethanol.
2. Name the functional group found in alcohols.
3. Describe the conditions needed for the hydration of ethene.
4. State the general formula of the alkanes.
5. State the pH range of an acid.

Drill:

1. Describe three ways of determining if a substance is an acid or an alkali.
2. Name some common acids.
3. Identify the ion that makes substances acidic.

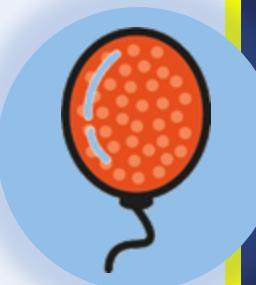


Taking it Further: Carboxylic Acids

Read Now:

Carboxylic acids are another homologous series of organic (carbon-containing compounds). As with other organic compounds, the carboxylic acids have many different uses for humans, and we use many of them without realising it. One of the most abundant carboxylic acids is ethanoic acid, which is sometimes also called acetic acid. This acid is the main component of vinegar (other than water) and is used to flavour different foods. Often ethanoic acid used in vinegar is made from a double fermentation process, where ethanol is made from plant sugars using yeast, then fermented again using bacteria to produce ethanoic acid.

1. Give an example of a carboxylic acid.
2. Give the other name for ethanoic acid.
3. Give one use for ethanoic acid.
4. Describe how ethanoic acid is made.



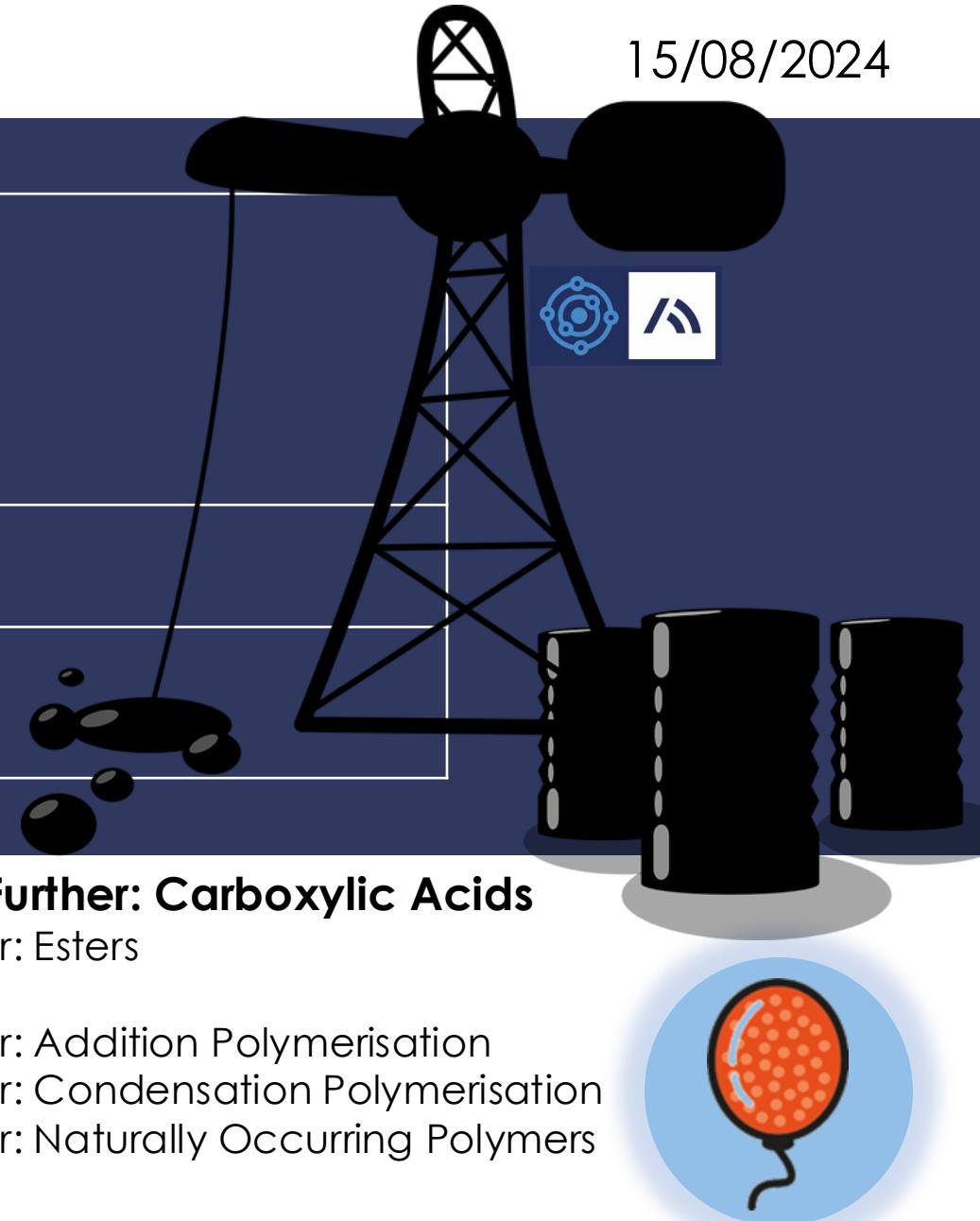
Taking it Further: Carboxylic Acids

C5.1.10

Science
Mastery

- C5.1.1 Prior Knowledge Review
- C5.1.2 Crude Oil and Hydrocarbons
- C5.1.3 Fractional Distillation
- C5.1.4 Combustion of Hydrocarbons
- C5.1.5 Cracking
- C5.1.6 Taking it Further: Alkenes
- C5.1.7 Taking it Further: Alcohols
- C5.1.8 Taking it Further: Producing Ethanol by Fermentation
- C5.1.9 Taking it Further: Producing Ethanol from Ethene

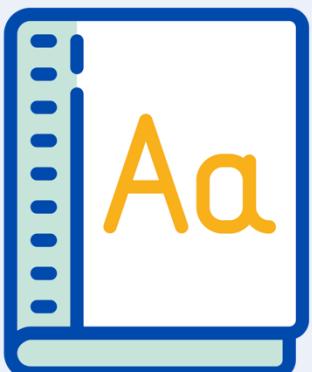
- **C5.1.10 Taking it Further: Carboxylic Acids**
- C5.1.11 Taking it Further: Esters
- C5.1.12 Polymers
- C5.1.13 Taking it Further: Addition Polymerisation
- C5.1.14 Taking it Further: Condensation Polymerisation
- C5.1.15 Taking it Further: Naturally Occurring Polymers



Following this lesson, students will be able to:

- Identify the functional group found in carboxylic acids
- Draw structural formulae of carboxylic acids
- Write chemical equations for reactions of carboxylic acids

Key Words:



| | | |
|-----------------|----------|--------------|
| carboxylic acid | carboxyl | -COOH |
| strong | weak | concentrated |
| | | dilute |

This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
 - **reteach, explanation, demonstration or modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
 - **practise** answering specific questions or of key skills.
 - **redrafting** or **improving** previous work.

Answer the questions below.

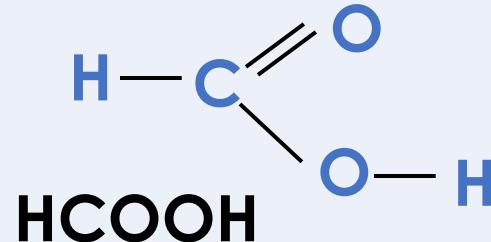
1. Choose the term for what happens when ethanol is made from ethene.
 A. Hydration
 B. Hydrogenation
 C. Fermentation
2. What is a disadvantage of making ethanol from ethene?
 A. Ethene is obtained from sugar cane so is renewable
 B. Ethene is obtained from crude oil so is non-renewable
 C. Ethene is obtained from biofuels so is renewable
3. What is an advantage of producing ethanol from ethene?
 A. It produces ethanol much more quickly than fermentation
 B. It is an energy intensive process
 C. It requires high temperatures and a catalyst

Carboxylic Acids

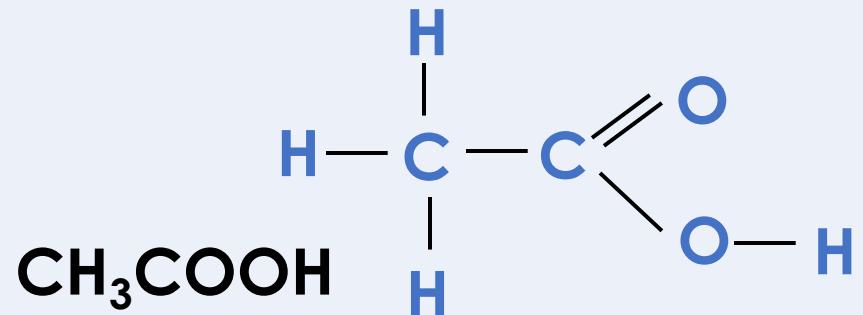
The **carboxylic acids** are another **homologous series**.

They contain a functional group called a **carboxyl group**, which can be written as -COOH.

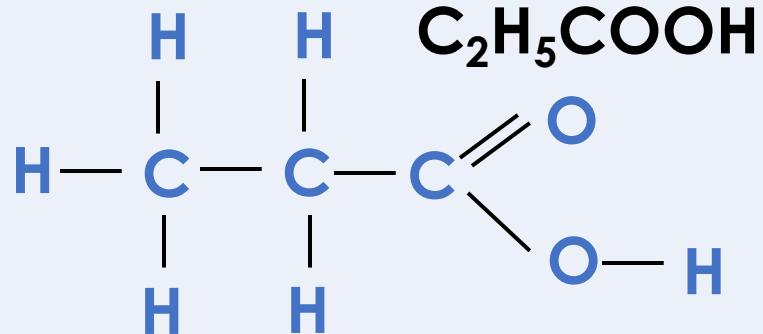
Methanoic acid



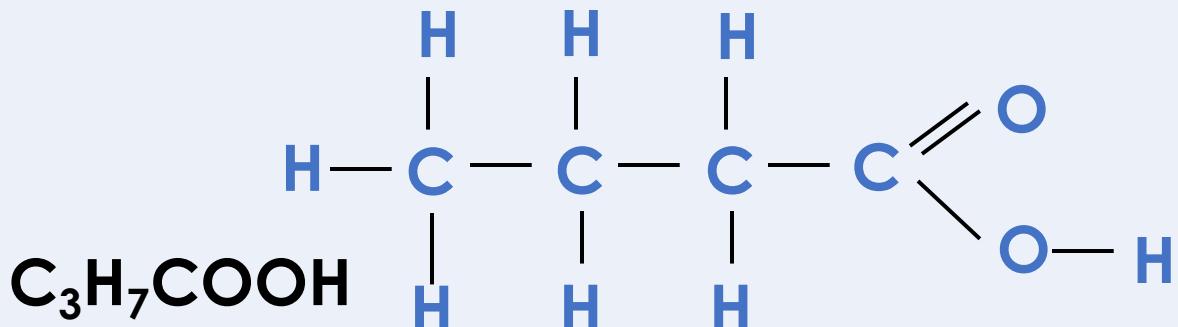
Ethanoic acid



Propanoic acid



Butanoic acid

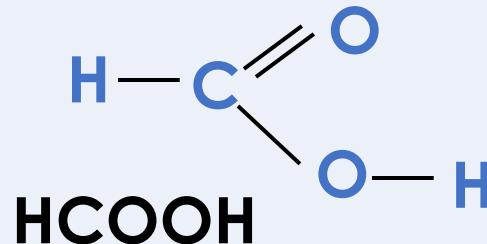


What is the general formula for the carboxylic acids?

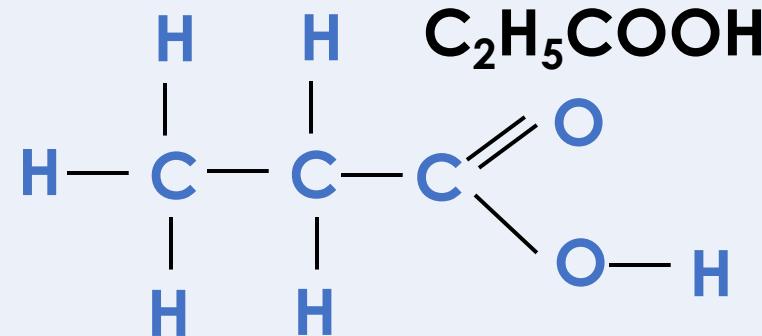
The general formula of the carboxylic acids can be written as:

- $C_nH_{2n+1}COOH$, where n is the number of carbon atoms in the molecule minus 1
- or $C_nH_{2n}O_2$)

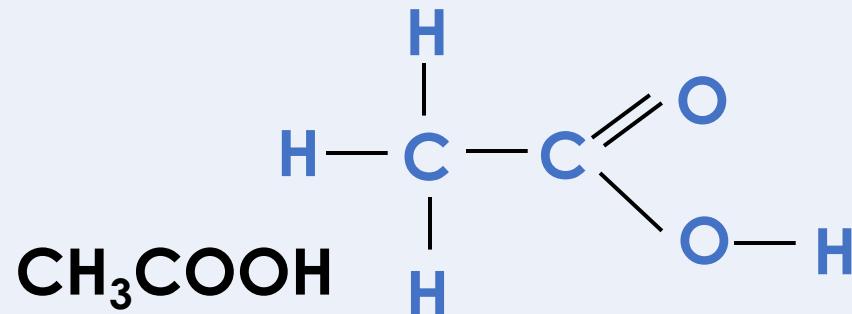
Methanoic acid



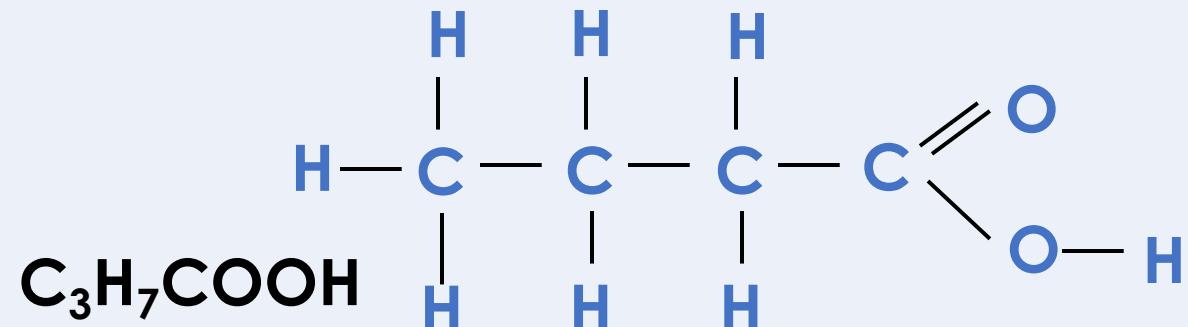
Propanoic acid



Ethanoic acid



Butanoic acid



Properties of Carboxylic Acids

Like the other **homologous series**, carboxylic acids show similar physical and chemical properties.

The carboxyl functional group is responsible for the chemical properties.

Carboxylic acids are **weak** acids, which dissolve in water to form acidic solutions with a **pH** of less than **7**.

Vinegar is a dilute solution of ethanoic acid.

Carboxylic acids can be formed through the **oxidation** of **alcohols** by an oxidising agent.



Reactions of Carboxylic Acids

Like other acids, carboxylic acids react with metals and metal compounds.

Acid + metal → **salt + hydrogen**

Acid + alkali → **salt + water**

Acid + base → **salt + water**

Acid + metal carbonate → **salt + water + carbon dioxide**

Which statements do you agree with?

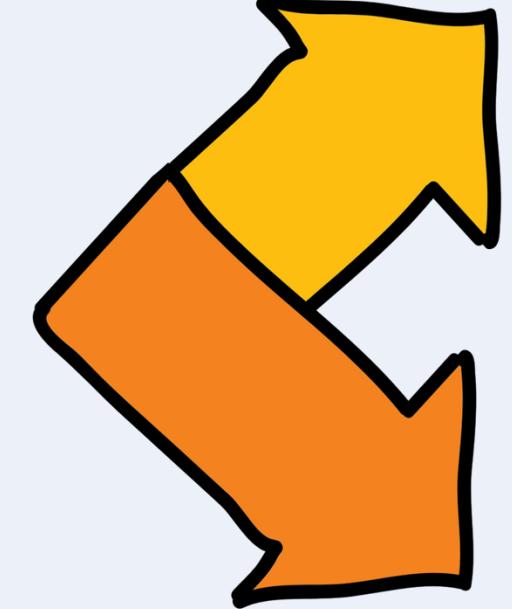
Carboxylic acids contain a C=C double bond

The function group in carboxylic acids is a carboxylic group

Methanoic acid has the formula CH_3COOH

Carboxylic acids are weak acids

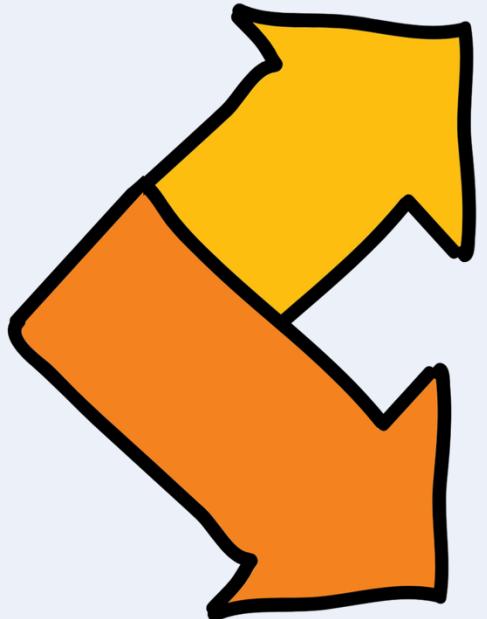
Can you explain the difference between these two terms?



Dilute acid

Concentrated acid

(HT) Can you explain the difference between these two terms?



Strong acid

Weak acid

Determine whether each of these statements is true or false

1. Methanoic acid has the formula HCOOH **True**
2. Propanoic acid contains four carbon atoms **False**
3. The functional group of carboxylic acids is the hydroxyl group **False**
4. Carboxylic acids are weak acids **True**
5. Carboxylic acids react with alkalis to form salts, water and hydrogen
 False

Drill

1. State the chemical formula of methanoic acid.
2. State the chemical formula of ethanoic acid.
3. Name the functional group of the carboxylic acids.
4. State the formula of the functional groups of the carboxylic acids.
5. State the pH values of solutions containing dissolved carboxylic acids.
6. State whether carboxylic acids are strong or weak acids.
7. State the products formed when a carboxylic acid reacts with a metal carbonate.
8. Write a general equation for the reactions between carboxylic acids and metal carbonates.

Drill answers

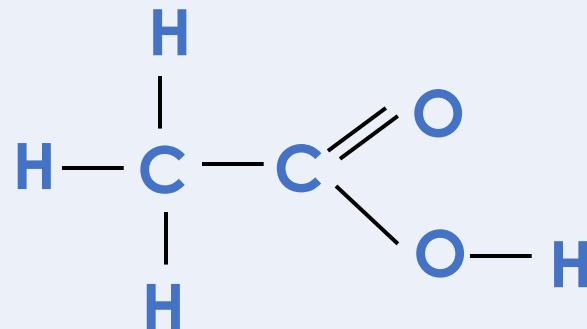
1. HCOOH
2. CH₃COOH
3. Carboxyl group
4. -COOH
5. Less than 7
6. Weak acids
7. Salt, water and carbon dioxide
8. Carboxylic acid + metal carbonate → salt + water + carbon dioxide

Check for understanding

I: Reactions of Carboxylic Acids

Calcium carbonate reacts with ethanoic acid.

Draw the structural formula for ethanoic acid.



State the chemical formula for ethanoic acid.



What products would be made in a reaction between a carboxylic acid and a metal carbonate?

A salt, water and carbon dioxide

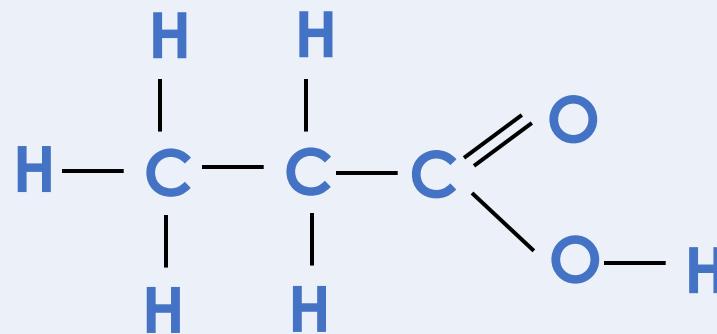
Write a word equation for this reaction.

Calcium carbonate + ethanoic acid → calcium ethanoate + water + carbon dioxide

We: Reactions of Carboxylic Acids

Sodium carbonate reacts with propanoic acid.

Draw the structural formula for propanoic acid.



State the chemical formula for propanoic acid.



What products would be made in a reaction between a carboxylic acid and a metal carbonate?

A salt, water and carbon dioxide

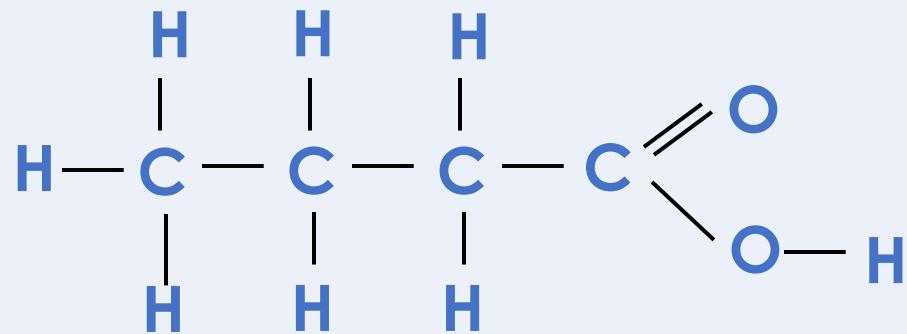
Write a word equation for this reaction.

Sodium carbonate + propanoic acid → sodium propanoate + water + carbon dioxide

You: Reactions of Carboxylic Acids

Magnesium carbonate reacts with butanoic acid.

Draw the structural formula for butanoic acid.



State the chemical formula for butanoic acid.



What products would be made in a reaction between a carboxylic acid and a metal carbonate?

A salt, water and carbon dioxide

Write a word equation for this reaction.



Answer the questions below.

1. Choose the functional group found in carboxylic acids.

- A. Hydroxyl group
- B. Carboxyl group
- C. Carboxylate group

2. Which carboxylic acid has the formula CH_3COOH ?

- A. Methanoic acid
- B. Ethanoic acid
- C. Propanoic acid

3. What are the products of a reaction between a carboxylic acid and a metal carbonate?

- A. A salt, water and carbon dioxide
- B. A salt, water and hydrogen
- C. A salt and water

Lesson C5.1.10

What was good about this lesson?

What can we do to improve this lesson?

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or by emailing sciencemastery@arkonline.org
Thank you!