

Exercise walk-through

11.7

Carboxylic acids

IGCSE Chemistry

Alkenes and the bromine test

shake with orange bromine water



alkene:
turns colourless



alkane:
stays orange

The $C=C$ makes alkenes reactive (**addition reactions**).

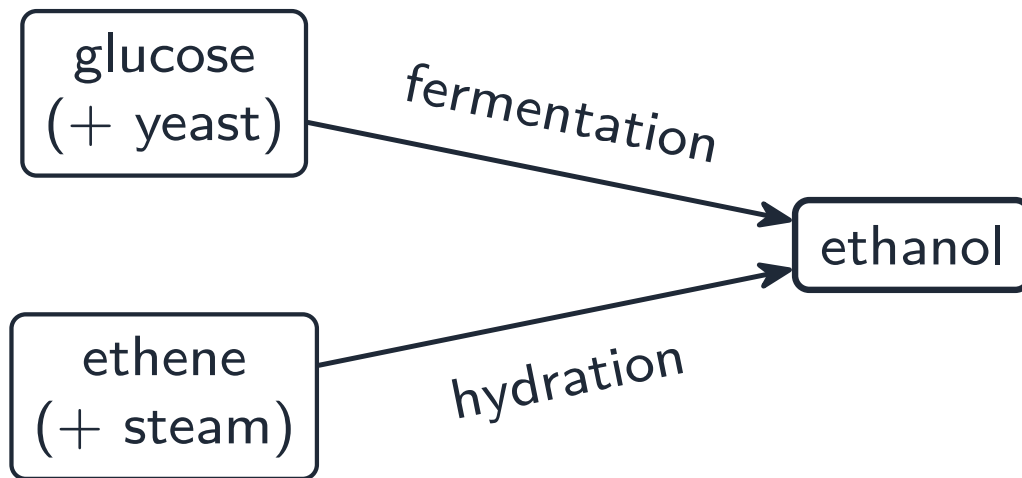
Test: shake with orange **bromine water**. An alkene **decolourises** it; an alkane does not.

Alcohols and ethanol

Ethanol (–OH) two ways:

- **fermentation** of glucose (yeast; renewable, slow)
- **hydration** of ethene (steam + catalyst; fast, pure)

Used as a fuel & **solvent** .



Two routes to ethanol, and what it becomes

Fermentation

Sugar with yeast at about 30 °C, no air – renewable, slow, and it gives a dilute product.

Hydration

Ethene plus steam over a catalyst – fast and pure, but it starts from crude oil.

Oxidation

Ethanol oxidises to **ethanoic acid** – which is what turns wine into **vinegar** .

Elsewhere in the topic

A **substitution reaction** swaps one atom for another – methane and chlorine under **ultraviolet light** – and **nickel** is the catalyst that adds hydrogen to an alkene.

Compare the two routes on the same three axes: raw material, energy, and purity of product.

Making ethanol, and making ethanoic acid

fermentation	glucose with yeast, about 30 °C, no air – slow, batch, and it uses a renewable feedstock
hydration of ethene	steam over a phosphoric acid catalyst, high temperature and pressure – fast, continuous, and it uses crude oil
the trade	fermentation is renewable and impure; hydration is pure and depends on a finite resource
oxidation of ethanol	gives ethanoic acid, using acidified potassium manganate(VII) or potassium dichromate(VI)
the acid's reactions	with metals, carbonates and alkalis – like any acid, and the salts formed are called ethanoates
lubricating oil	one of the crude-oil fractions – used for lubricants, waxes and polishes

The two routes to ethanol is a standard compare-and-evaluate question. Name the conditions for each **and** say which resource it depends on.

Carboxylic acids and esters



Carboxylic acids ($-\text{COOH}$)
react with metals, bases &
carbonates (giving ethanoates).

Acid + alcohol $\xrightarrow{\text{catalyst}}$ an
ester + water.

Exercises 2.1·2.2

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]

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2.1

- the carboxylic acid functional group is **–COOH** (carboxyl)

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

2.2

- carboxylic acid + alcohol → an **ester**

Exercise 3.1

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

[1]

☐

A hydrogen

B oxygen

C carbon dioxide

D chlorine

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3.1 C

- acid + carbonate $\rightarrow$ salt + water + **carbon dioxide**
- A is acid + metal; B and D are wrong

Exercise 3.2 (a)

3.2 Ethanoic acid can be made by oxidising ethanol.

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

[1]

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(a)

- **acidified potassium manganate(VII)**

Exercise 3.2 (b)

3.2 Ethanoic acid can be made by oxidising ethanol.

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

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

(b)

- the everyday product is **vinegar**

Exercise 3.3

3.3 Magnesium reacts with ethanoic acid. Name the two products.

[2]

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3.3

- magnesium ethanoate and hydrogen

Exercise 3.4 (a)

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

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(a)

- CH_3 joined to a carbon with a double-bonded O and $-\text{OH}$, all bonds shown
- circled $-\text{COOH}$ is the **carboxyl** group

Exercise 3.4 (b)

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(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]

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(b)

- (i) **effervescence**; magnesium disappears; **hydrogen**; magnesium ethanoate
- (ii) **effervescence**; gas turns limewater milky (CO_2)
- $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$

Exercise 3.4 (c)

3.4 Ethanoic acid, CH_3COOH , is a weak acid.

(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]

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- **esterification**
- product: **ethyl ethanoate** (sweet, fruity)
- sulfuric acid is a **catalyst**

Exercise 3.4 (d)

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(d)

- a weak acid only **partly ionises**
- far fewer H^+ than a strong acid of the same concentration
- its pH is **higher** (about 3–4 vs about 1 for HCl)