

Exercise walk-through

11.5

Alkenes

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**).

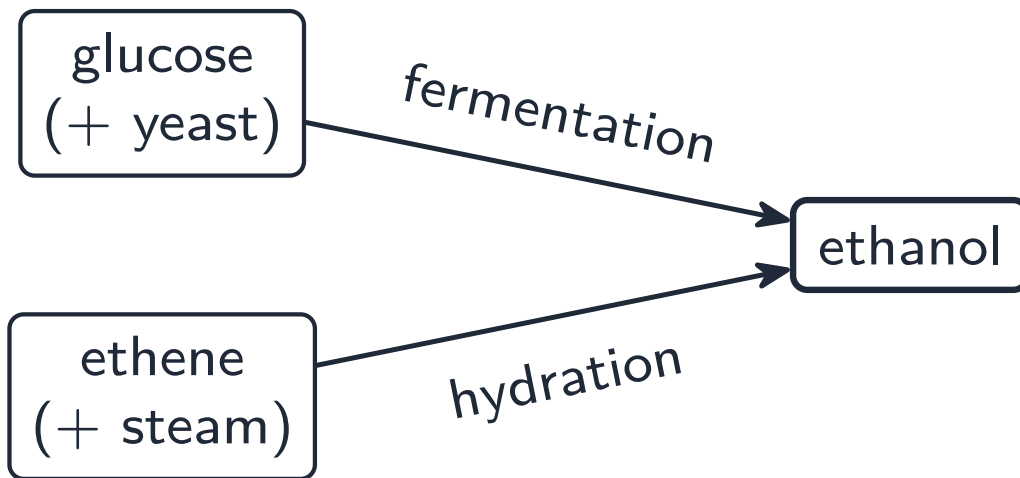
Test: shake with orange **bromine water**. An alkene **decolourises** it; an alkane does not.

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 2.1-2.3

2.1 State the functional group in an alkene. [1]

2.2 State what cracking does. [1]

2.3 Write a balanced equation for cracking $\text{C}_{14}\text{H}_{30}$ to give octane, C_8H_{18} , and one alkene. [2]

Exercises 2.1·2.3

2.1 State the functional group in an alkene. [1]

2.1

- the alkene functional group is the **C=C** double bond
-

2.2 State what cracking does. [1]

2.2

- cracking **breaks large alkanes into smaller, more useful molecules** (alkanes and alkenes)
-

2.3 Write a balanced equation for cracking $\text{C}_{14}\text{H}_{30}$ to give octane, C_8H_{18} , and one alkene. [2]

2.3

- remaining fragment: $14 - 8 = 6$ carbons, $30 - 18 = 12$ hydrogens
- $\text{C}_{14}\text{H}_{30} \rightarrow \text{C}_8\text{H}_{18} + \text{C}_6\text{H}_{12}$

Exercises 2.4·2.5

2.4 State the reagent and the catalyst used to convert ethene into ethanol. [2]

2.5 Explain, in terms of bonding, why ethene decolourises bromine water but ethane does not. [2]

Exercises 2.4·2.5

2.4 State the reagent and the catalyst used to convert ethene into ethanol. [2]

2.4

- reagent: **steam**
 - catalyst: **phosphoric acid**, at high pressure
-

2.5 Explain, in terms of bonding, why ethene decolourises bromine water but ethane does not. [2]

2.5

- ethene has a C=C that can **open** so bromine **adds**
- ethane is **saturated**, so bromine cannot add

Exercise 3.1

3.1 When ethene is shaken with bromine water, the bromine water:

[1]

☐

A stays orange

B turns colourless

C turns blue

D turns purple

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[1]

☐

A stays orange

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3.1 B

- the alkene **turns bromine water colourless**
- A is an alkane; C and D are other tests

Exercise 3.2 (a)

3.2 Cracking breaks decane ($\text{C}_{10}\text{H}_{22}$) into octane (C_8H_{18}) and one other product.

(a) Name the type of compound formed as the other product.

[1]

Exercise 3.2 (a)

3.2 Cracking breaks decane ($\text{C}_{10}\text{H}_{22}$) into octane (C_8H_{18}) and one other product.

(a) Name the type of compound formed as the other product.

[1]

(a)

- the other product is an **alkene**

Exercise 3.2 (b)

3.2 Cracking breaks decane ($\text{C}_{10}\text{H}_{22}$) into octane (C_8H_{18}) and one other product.

(b) Give the molecular formula of the other product.

[1]

Exercise 3.2 (b)

3.2 Cracking breaks decane ($\text{C}_{10}\text{H}_{22}$) into octane (C_8H_{18}) and one other product.

(b) Give the molecular formula of the other product.

[1]

(b)

- $10 - 8 = 2$ carbons, $22 - 18 = 4$ hydrogens
- C_2H_4

Exercise 3.3

3.3 Describe how you could use bromine water to tell an alkene from an alkane. [2]

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3.3

- add **bromine water** and shake
- alkene: **colourless**; alkane: stays **orange**

Exercise 3.4 (a)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(a) State two conditions used for cracking.

[2]

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(a) State two conditions used for cracking.

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(a)

- high temperature, about 600–700 °C
- a catalyst, e.g. **aluminium oxide** or silica

Exercise 3.4 (b)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(b) Explain why a refinery cracks long-chain alkanes.

[2]

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(b) Explain why a refinery cracks long-chain alkanes.

[2]

(b)

- long-chain fractions are in surplus and make **poor fuels**
- cracking makes **petrol** and **alkenes** for polymers

Exercise 3.4 (c)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(c) Decane is cracked to give one molecule of octane and one other product. Write the balanced equation and name the second product. [3]

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(c)

- $\text{C}_{10}\text{H}_{22} \rightarrow \text{C}_8\text{H}_{18} + \text{C}_2\text{H}_4$
- the second product is **ethene**

Exercise 3.4 (d)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(d) Describe a test that would distinguish the second product from octane, giving the result for each. [3]

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(d)

- shake with **orange bromine water**
- ethene **decolourises** it; octane leaves it **orange**

Exercise 3.4 (e)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(e) The alkene product is reacted with steam. Name the product, state the catalyst, and give the type of reaction. [3]

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(e) The alkene product is reacted with steam. Name the product, state the catalyst, and give the type of reaction. [3]

(e)

- product: **ethanol**
- catalyst: **phosphoric acid**
- type: **addition / hydration**

Exercise 3.4 (f)

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(f) Explain why the alkene can take part in addition reactions but octane cannot. [2]

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3.4 A refinery cracks decane, $C_{10}H_{22}$.

(f) Explain why the alkene can take part in addition reactions but octane cannot. [2]

(f)

- the alkene has a $C=C$ that can **open**, so atoms add with nothing lost
- octane is **saturated**, so it can only react by **substitution**