

Alcohols

4.7.2.3 · Organic chemistry · revision notes

The alcohols: the –OH functional group, the first four alcohols, their reactions with sodium, air, water and oxidising agents, their uses, and making ethanol by fermentation. GCSE Chemistry only. Expect naming, observations, combustion equations, fermentation conditions and evaluate questions based on data.

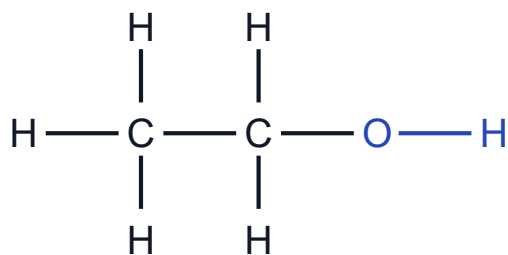
Key facts

- Functional group of the alcohols: –OH
- Alcohol + sodium: fizzing, hydrogen given off
- Alcohol + oxidising agent → carboxylic acid (ethanol → ethanoic acid)
- $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
- $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
- Methanol CH_3OH , ethanol C_2H_5OH , propanol C_3H_7OH , butanol C_4H_9OH
- Alcohol + water: dissolves, neutral solution (pH 7)
- Complete combustion: alcohol + oxygen → carbon dioxide + water
- Fermentation: sugar solution + yeast, about 30 °C, no air
- Uses: fuels, solvents; ethanol in alcoholic drinks

Notes

The alcohols

- Alcohols contain the –OH functional group. They are not hydrocarbons, because they contain oxygen.
- The first four: **methanol** CH_3OH , **ethanol** CH_3CH_2OH , **propanol** $CH_3CH_2CH_2OH$ and **butanol** $CH_3CH_2CH_2CH_2OH$. You may see ethanol written as C_2H_5OH .
- Ethanol:



- Recognise an alcohol by the name ending **-ol**, or by an –OH group bonded to a carbon chain.

Reactions of the first four alcohols

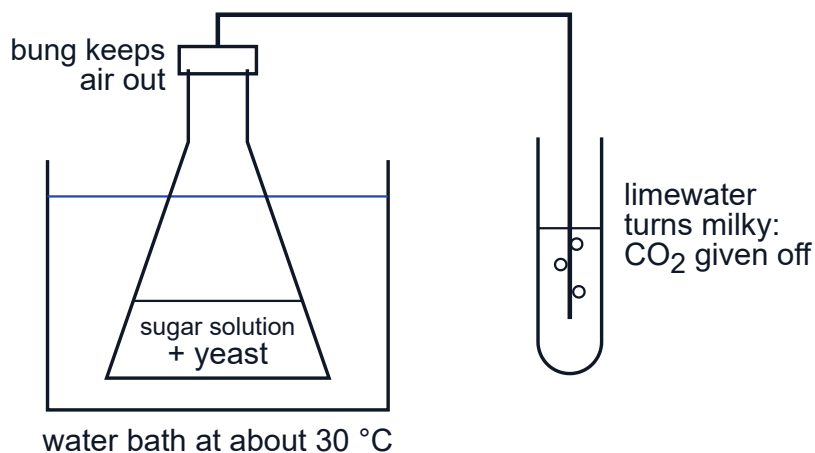
- **Sodium:** fizzing, as bubbles of **hydrogen** are given off, and the sodium gets smaller. It is less vigorous than sodium with water.
- **Burning in air:** complete combustion gives carbon dioxide and water and releases energy: $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$.
- **Added to water:** they dissolve to form a **neutral** solution (pH 7). Methanol, ethanol and propanol mix completely with water; butanol is less soluble.
- **Oxidising agent:** the alcohol is oxidised to a **carboxylic acid**, e.g. ethanol $\rightarrow$ ethanoic acid.
- You only need to write balanced equations for combustion. For the other reactions, know what you would see and name the products.

Uses

- **Fuels:** e.g. ethanol, which can be mixed with petrol.
- **Solvents:** e.g. ethanol in perfumes, cosmetics and hand gels.
- Ethanol is the main alcohol in **alcoholic drinks**.

Fermentation

- Aqueous solutions of ethanol are made by **fermenting** sugar solutions using **yeast**.
- Conditions: sugar dissolved in water, yeast, a warm temperature (about 30 °C) and **no air** (anaerobic).



Fermentation: warm, no air, yeast. The carbon dioxide turns limewater milky.

- glucose $\rightarrow$ ethanol + carbon dioxide: $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$
- The product is a dilute solution of ethanol, which can be concentrated by fractional distillation.

How to answer each type of question

Describe what you would see

2 to 4 marks

Grade 5

1. Give observations, not just product names: fizzing, bubbles, the sodium getting smaller.
2. Name any gas produced: hydrogen with sodium.
3. With water, say that the alcohol dissolves and that the solution is neutral.

Example. A student tests ethanol in two ways.

(a) Ethanol is added to water containing universal indicator. What colour is the indicator? Give a reason.

(b) A small piece of sodium is added to ethanol. Describe **two** things the student would see.

Model answer. (a) Green (1), because ethanol forms a neutral solution, pH 7 (1).

(b) Fizzing or bubbles of gas (1). The sodium gets smaller and disappears (1).

Don't lose marks

- ✗ Calling ethanol a hydrocarbon. It contains oxygen.
- ✗ Saying alcohols form acidic or alkaline solutions. Their solutions are neutral (pH 7).
- ✗ Saying sodium and an alcohol give oxygen or carbon dioxide. The gas is hydrogen.
- ✗ Forgetting the H in the $-OH$ when counting hydrogen atoms for a combustion equation.
- ✗ Saying fermentation needs a high temperature. It needs a warm temperature; too hot denatures the enzymes.

More tips

Memory tricks

- '-ol' means alcohol: methanol, ethanol, propanol, butanol.
- Counting hydrogens: C_2H_5OH has $5 + 1 = 6$ H atoms, which make $3H_2O$.
- Alcohol combustion: an alcohol with n carbon atoms needs $1.5n$ molecules of O_2 . Ethanol needs 3; butanol needs 6.
- Oxidising an alcohol gives the acid with the same number of carbons: ethanol $\rightarrow$ ethanoic acid, propanol $\rightarrow$ propanoic acid.
- Fermentation needs a warm, airless, sugary home for the yeast.

Exam technique

- In 'describe what you would see' questions, give observations (fizzing, the sodium disappears), not just 'hydrogen is made'.
- Balanced equations are only expected for alcohol combustion. For other reactions, word equations and names are enough.
- In evaluate questions, give points for and against each method and finish with a conclusion that follows from them.
- Give the fermentation temperature as a number (about $30^\circ C$) as well as the word 'warm'.

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 the alcohols

The –OH group.

Grade 3

Give the main uses of alcohols

As fuels and solvents; ethanol is the main alcohol in alcoholic drinks.

Grade 4

Name and draw the first four alcohols

Methanol, ethanol, propanol and butanol; ethanol is $\text{CH}_3\text{CH}_2\text{OH}$.

Grade 4

State the conditions for fermentation

Sugar solution, yeast, a warm temperature (about 30 °C) and no air.

Grade 5

Describe the reactions of alcohols

Sodium: fizzing (hydrogen). Water: dissolves, neutral solution. Oxidising agent: a carboxylic acid forms.

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