

Hydroxy Compounds

A-Level Chemistry ■ Topic 16

A-Level Chemistry



What we will cover

- 1 Alcohols & three classes
- 2 Oxidation by class
- 3 The dichromate test
- 4 Distillation vs reflux
- 5 Other reactions



ethanol kills microbes



Alcohols and three classes

Count how many carbons are attached to the C that carries the OH.

primary

one C – ethanol,
oxidises to aldehyde then acid

secondary

two C – propan-2-ol,
oxidises to a ketone

tertiary

three C – 2-methylpropan-2-ol,
does *not* oxidise

Four ways to make an alcohol

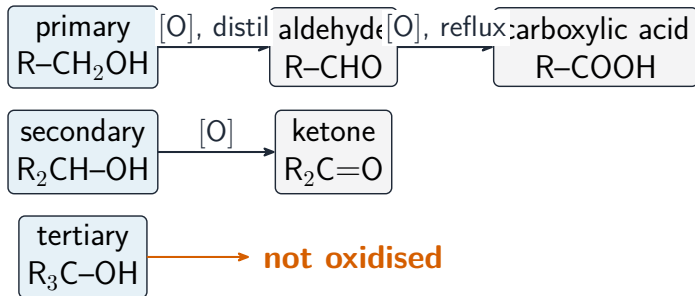
Method	Reagents and conditions
hydration of an alkene	steam, H_3PO_4 (electrophilic addition)
reduction of an aldehyde or ketone	NaBH_4 or LiAlH_4
an alkene with cold dilute KMnO_4	gives a diol – two $-\text{OH}$ groups
substitution of a halogenoalkane	NaOH(aq) , heat under reflux
hydrolysis of an ester	dilute acid or alkali, heat

NaOH in **water** substitutes to the alcohol; NaOH in **ethanol** eliminates to the alkene. Same reagent, different solvent, different product.

Oxidation by class

With acidified $\text{K}_2\text{Cr}_2\text{O}_7$:

- primary $\rightarrow$ **aldehyde** $\rightarrow$ **carboxylic acid**
- secondary $\rightarrow$ a **ketone**
- tertiary $\rightarrow$ **not oxidised**



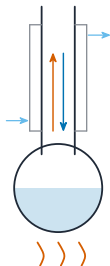
The dichromate test

Acidified **dichromate** turns **orange to green** with a primary or secondary alcohol, but stays orange with a tertiary one.

warm with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ (orange)

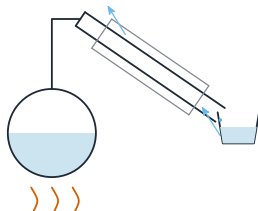


Distillation vs reflux



reflux

vapour returns: fully
oxidised to the acid



distillation

product distils off as
it forms (the aldehyde)

- **distillation** removes the aldehyde as it forms – stops at the aldehyde
- **reflux** keeps boiling & returning the vapour – fully oxidises to the acid

Other reactions

combustion

dehydration → alkene

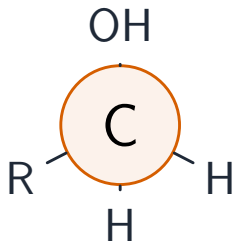
esterification

with Na → H₂

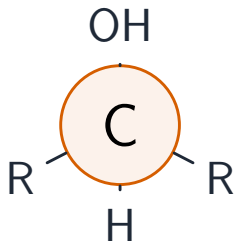
substitution → halogenoalkane

The **acidity** of alcohols is very weak – **less** than water (the alkyl group destabilises RO⁻). The **iodoform test** detects the CH₃CH(OH)– group.

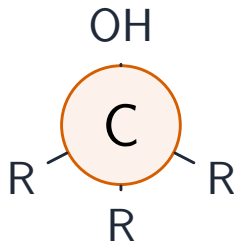
Three classes and how oxidation tells them apart



primary (1 R)



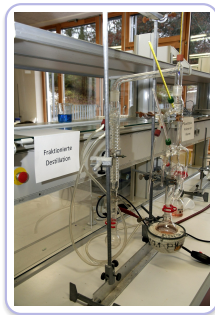
secondary (2 R)



tertiary (3 R)

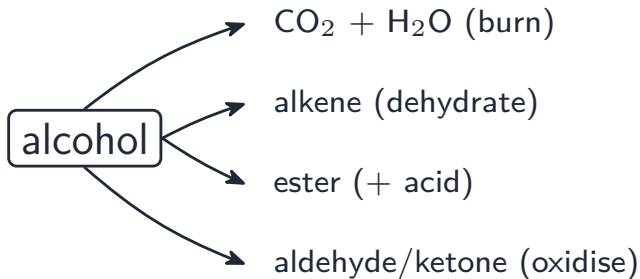
The class is set by the carbon holding the -OH : one R group makes it primary, two secondary, three tertiary – which decides how it oxidises

Three classes and how oxidation tells them apart, continued



A real distillation set-up: the vapour boils off, cools in the condenser and is collected – the same idea separates ethanol from a fermented mixture

Reactions of alcohols



With sodium an alcohol gives hydrogen and a sodium alkoxide – like water, but more slowly. The **iodoform test** : warm an alcohol carrying $\text{CH}_3\text{CH}(\text{OH})-$ with alkaline aqueous iodine and a pale yellow precipitate of tri-iodomethane appears.

Exam tips

- Classify the alcohol as **primary, secondary or tertiary** first – it decides the oxidation product.
- **Oxidation** with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ (orange $\rightarrow$ green): primary $\rightarrow$ aldehyde (distil) $\rightarrow$ acid (reflux); secondary $\rightarrow$ ketone; tertiary $\rightarrow$ no reaction.
- Distinguish the conditions for **aldehyde vs acid** from a primary alcohol (distillation vs reflux).
- Name esters correctly (the acid part comes second, ending “-oate”).



Worked example – oxidising an alcohol

Oxidise (a) propan-1-ol and (b) propan-2-ol. How do you stop at the aldehyde?

- (a) Primary → **propanal** (aldehyde) → **propanoic acid**.
- Stop at the aldehyde by **distilling it off as it forms** – its b.p. is lower.
- **Reflux** with excess oxidant to go all the way to the acid.
- (b) Secondary → **propanone**, and it stops there.
- Both turn the dichromate **orange** → **green**.

Primary → aldehyde → acid;
secondary → ketone; tertiary
→ **no reaction** (no H on the C–OH carbon).

Topic 16 – key takeaways

1

Classes

primary, secondary, tertiary

2

Oxidation

1° to aldehyde/acid; 2° to ketone; 3° none

3

Dichromate

orange to green for 1° & 2°

4

Apparatus

distillation stops early; reflux goes all the way

Check yourself

- 1 What does a secondary alcohol oxidise to?
- 2 Which class is not oxidised by dichromate?
- 3 Which apparatus fully oxidises to the acid?
- 4 Are alcohols more or less acidic than water?



Answers 1. a ketone 2. tertiary 3. reflux 4. less acidic