# Alcohols

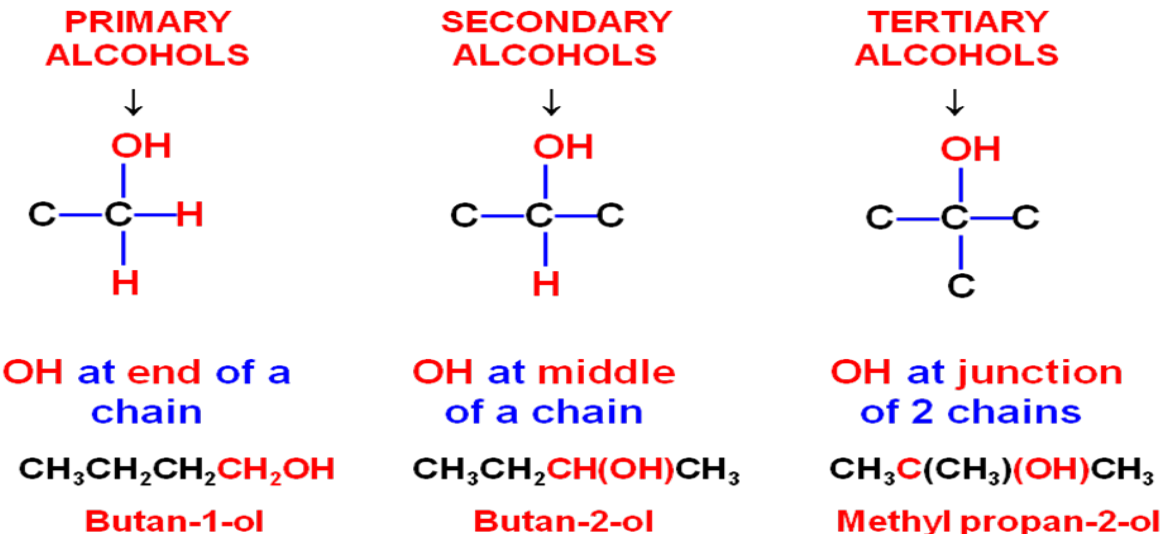
## Properties and preparation of ethanol

The three smallest alcohols are completely miscible with water, but the larger ones are immiscible. The alkane part of the alcohol is non-polar and behaves like oil, being immiscible with water. The OH group is hydrophilic, due to its similarity to the water molecule, and hydrogen bonds exist between an oxygen lone pair and a hydrogen atom in water and ethanol molecules. Miscibility decreases as chain length increases.

Alcohols have low volatility (high b.p.) compared to alkanes of similar mass due to H bonds between molecules.

## Reactions of alcohols

**Classification of alcohols**




**Primary alcohols** contain a $CH_2OH$ group **secondary** contain CHOH **tertiary** COH

### 1. Combustion

| **Ethanol** | **+** | **oxygen** | **→** | **carbon dioxide** | **+** | **water** |
|---|---|---|---|---|---|---|
| $C_2H_5OH$ | + | $3O_2$ | → | $2CO_2$ | + | $3H_2O$ |

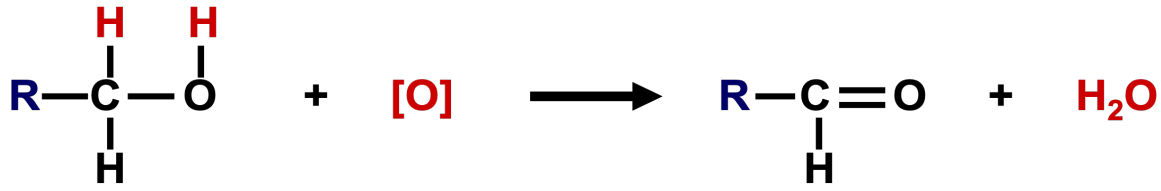
### 2. Oxidation of alcohols

On heating with acidified aqueous potassium dichromate (VI), the orange solution turns green.

As 1y and 2y alcohols are oxidised to different products and 3y are not oxidised, this reaction is used to distinguish between 1y, 2y and 3y alcohols.

On **gentle** heating, **primary alcohols** are oxidised to **aldehydes (RCHO)** that can be **distilled off** as they are formed.

**ethanol + [O] $\xrightarrow{K_2Cr_2O_7/H_2SO_4}$ ethanal + water**




**Under reflux** with **excess** acidified dichromate, aldehydes are oxidised to carboxylic acids, RCOOH. Reflux is the continual evaporation and condensation of the reaction mixture.

**ethanal + [O] → ethanoic acid**

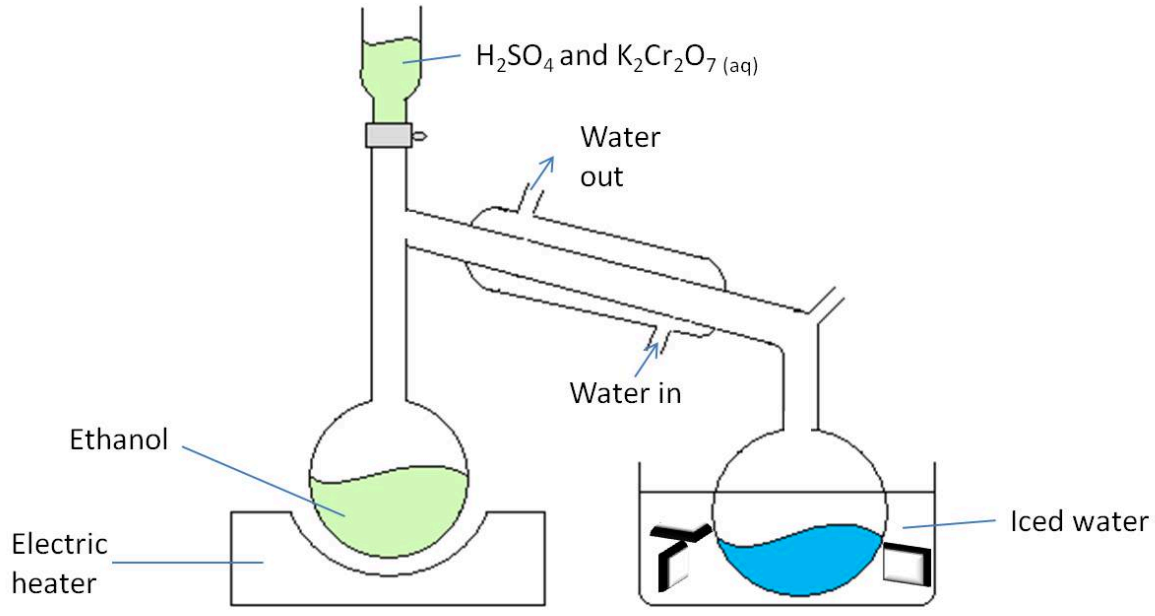
**$CH_3CHO$ + [O] → $CH_3COOH$**

**Overall equation for an alcohol oxidized to carboxylic acid:**

**ethanol + 2[O] → ethanoic acid + $H_2O$**

**$CH_3CH_2OH$ + 2[O] → $CH_3COOH$ + $H_2O$**

**Apparatus used:**
**Oxidation to aldehydes**



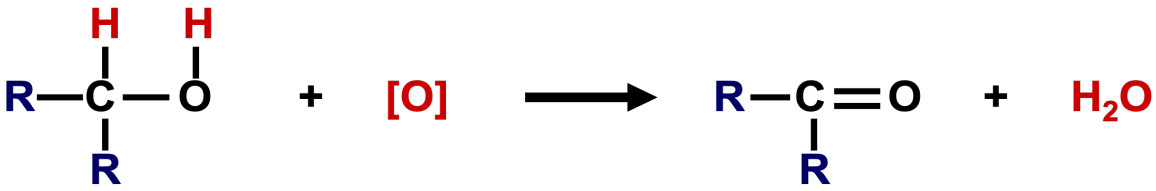
## OXIDATION TO CARBOXYLIC ACIDS

**REFLUX**

**Aldehyde condenses back into the mixture and gets oxidised to the acid**

**Secondary alcohols** produce **ketones** (RCOR') on gentle heating with acidified dichromate. No further oxidation is possible.

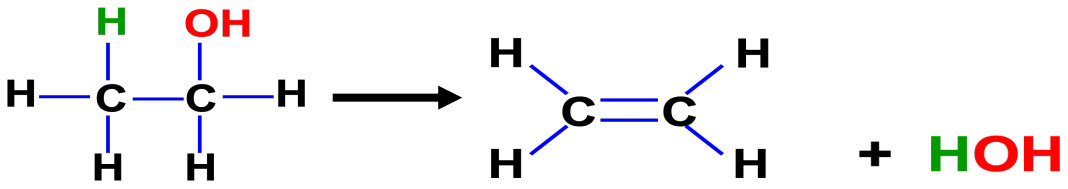
**propan-2-ol + [O] → propanone + water**



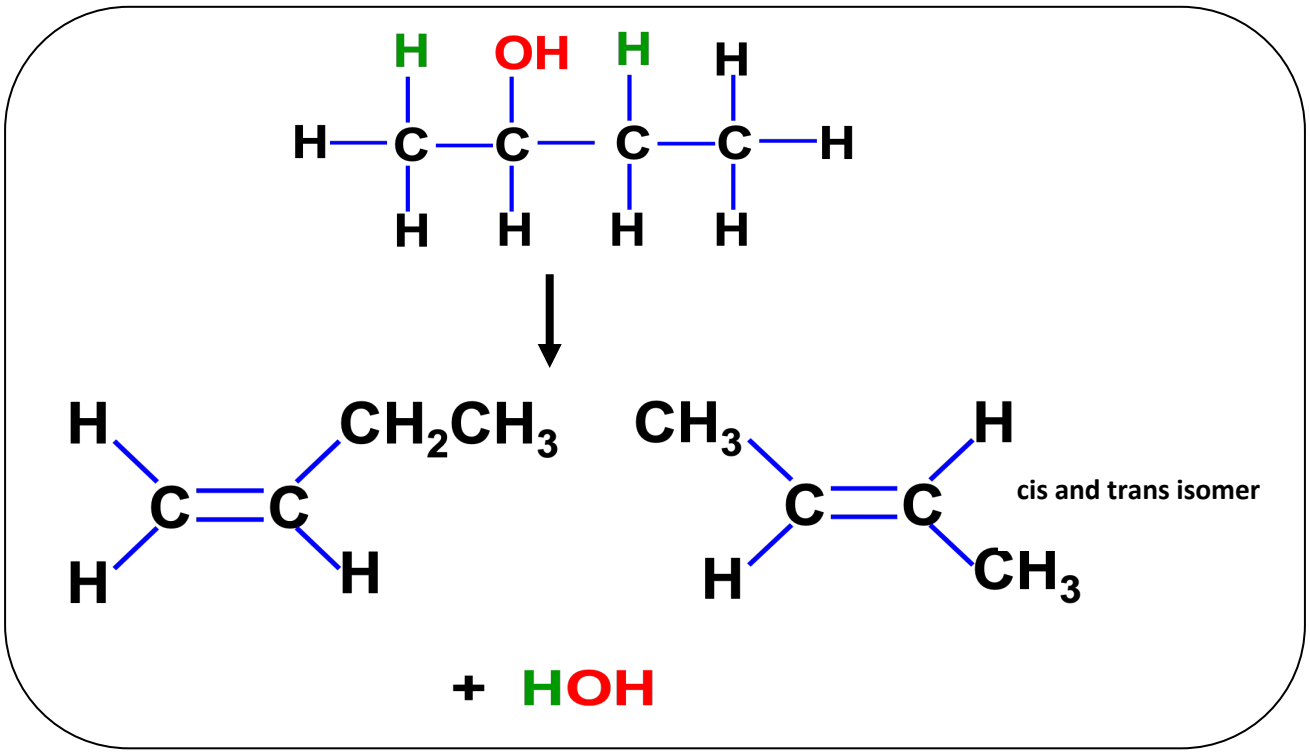

**Tertiary alcohols** are not oxidised. For oxidation to take place easily you must have two hydrogen atoms on adjacent C and O atoms. This is possible in 1° and 2° alcohols but not in 3° alcohols.

3. **Dehydration** to form an alkene by heating with concentrated sulphuric acid. This can also be described as an elimination reaction.

**ethanol → ethene + steam**




H and OH are lost from adjacent C atoms so a mixture of isomers is formed from some alcohols, e.g. dehydration of butan-2-ol.




**4. Substitution with halide ions in the presence of acid (e.g. NaBr/$H_2SO_4$) to form haloalkanes.**

ROH + HX → RX + $H_2O$

The acid reacts with NaBr to produce HBr in situ.