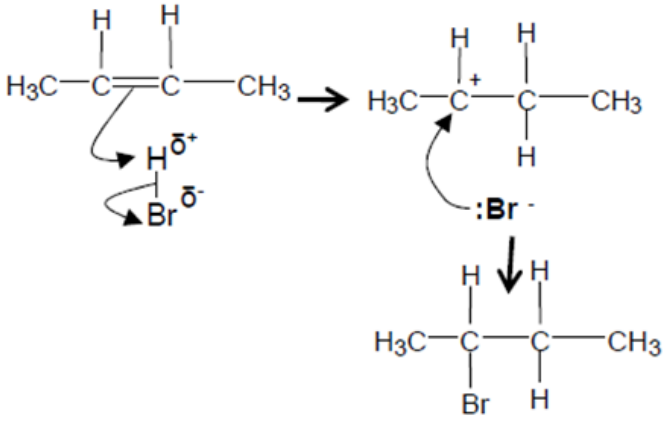
Alkenes & Alcohols knowledge organiser

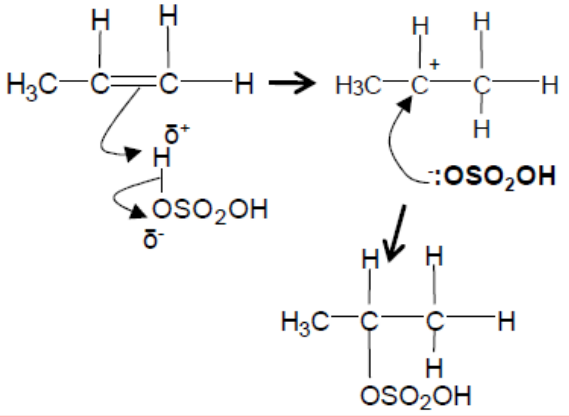
1. Keywords

Carbocation	ion with a positively charged carbon atom.
Electrophile	Electron pair accepting groups

Electrophilic Addition of Alkenes with hydrogen bromide



Electrophilic Addition of Alkenes with sulphuric acid



2. Properties

General formula C_nH_{2n}

Alkene's functional group is the C=C double bonds which consists of a sigma bond and a pi bond.
- The pi bond lies above and below the sigma bond.
- There is no rotation around a double bond – resulting in geometric isomers (cis/trans E/Z)
- The double bond sits on a plane and the angles between each bond is roughly 120°

Physical properties are very similar to those of the alkanes.

Chemical properties are influenced by the double bond that had an enthalpy of 612kJ/mol (a C-C bond has a bond enthalpy of 347kJ/mol) and it is an electron rich area which can easily attract electrophiles

3. Reactions

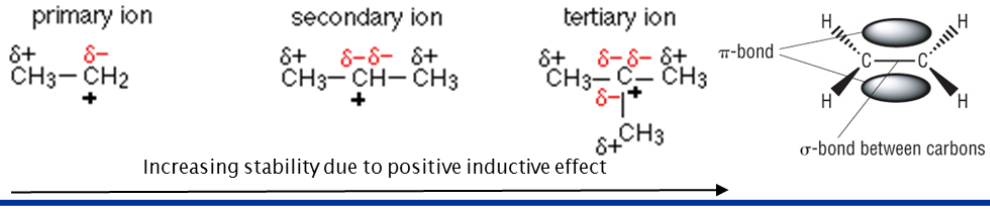
Combustion – alkenes will burn in oxygen like alkanes.

Electrophilic additions reactions undergo via carbocation. Main products are determined by the stability of the carbocation.

- Hydrogenation - ethene reacts with hydrogen in the presence of a finely divided nickel catalyst at a temperature of about 150℃. Ethane is produced $CH_2=CH_2 + H_2$ à CH_3CH_3

Uses of hydrogenation – Process used to manufacture margarine from unsaturated vegetable oils in palm and sunflower seeds. Vegetable oils = liquids, have double carbon bonds that are mostly cis-double bonds. These get converted to C-C bonds, turns liquid oils into spreadable fatty solids like margarine.

- Alkenes and steam – react in presence of phosphoric acid catalyst to produce alcohols. Generally reversible reaction. 570K, 65 atm pressure, $C_2H_4 + H_2O$ à CH_3CH_2OH
- Alkenes and halogens – Cl_2 and Br_2 react rapidly at room temperature with alkenes to form dihalogenoalkanes via electrophilic addition reaction. Reaction with iodine is slower.
  - the reaction with bromine water is the qualitative test for alkenes. Shake alkene with bromine water, orange solution goes colourless.
- Alkenes with hydrogen halides –react readily at room temperature with alkenes, form halogenoalkanes. Un-symmetrical alkenes will react to produce a major and minor product.
- Alkenes with hydrogen halides – reacts at room temperature and it is exothermic the sulfuric acid acts as a catalyst and the product is an alcohol.



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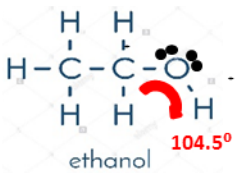
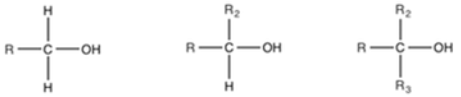
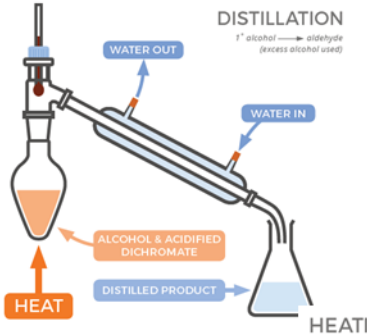
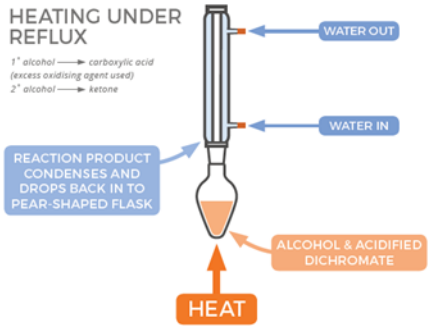




	Hydration of ethene	Fermentation of sugars
Method	Requires laboratory equipment; high level of expertise – cracking and hydration.	Can be undertaken at home – fermentation
Sustainability	Non-renewable	**Renewable**
Rate of reaction	**Fast**	Slow
Type of process	**Continuous**	Batch
Purity	Essentially pure, although any contaminants may be toxic	Low, aqueous solution of alcohol is produced; can be distilled to increase ethanol content and improve purity
Percentage yield	**90–100%**	~15%
Atom economy	**100%**	51%
By-products	None	Carbon dioxide – a greenhouse gas





1. Physical properties

General formula $C_nH_{2n+1}OH$

- Alcohols are classified into primary, secondary and tertiary based on the substitution of the carbon linked to the -OH group, like the halogenoalkanes.
- The –OH group allows alcohols to form hydrogen bonds.
- Short alcohols are soluble in water

2. Production of ethanol

Ethanol is the most important alcohol in industrial chemistry since it is used as intermediate in reactions and as solvent.

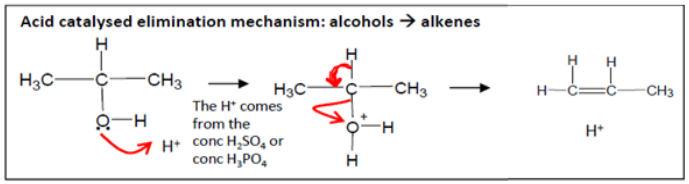
Ethanol can be made industrially in two ways:
-Hydration of ethane in the presence of phosphoric acid as catalyst (high yield, little sustainability)
$C_2H_4 + H_2O$ à C_2H_5OH -Fermentation of sugars (batch production, renewable)

$$C_6H_{12}O_6\,(aq) \text{ à } 2C_2H_5OH\,(aq) + CO_2(g)$$

3. Reactivity

-Combustion, all alcohols are flammable and can undergo complete or incomplete combustion, like alkanes.

-Elimination: it is a dehydration reaction with conc sulphuric or phosphoric acid or by passing its vapours over heated aluminium oxide.
An alkene is formed.



-Oxidation: alcohols can be oxidised ins stages, usually potassium dichromate (VI) is used since its reduction into chromium (III) ions translates into a change of colour from orange to green.

- Partial oxidation to aldehydes (if primary alcohol) or ketones (if secondary) is done with a distillation apparatus.
- Complete oxidation of a primary alcohol (or aldehyde) to carboxylic acid is performed in the presence of potassium dichromate (VI) under reflux.
- Oxidation is also used as a test for alcohols or to distinguish primary alcohols from the others

-Substitution: alcohols undergo substitution reactions to form haloalkanes with halide ions in the presence of an acid ($NaBr/H_2SO_4$).

The order of reactivity of alcohols is 3˚ > 2˚ > 1˚.
The order of reactivity of the hydrogen halides is NaI > NaBr > NaCl (NaF is generally unreactive).