KNOWLEDGE

Chemistry Topic 10 Organic reactions (triple)

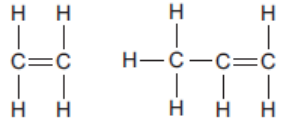
ORGANISER

Section 1: Key terms

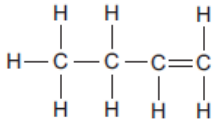
Functional group	An atom or group of atoms that give organic compounds their characteristic reactions.
Homologous series	Family of organic compounds with the same functional group.
Double bond	A covalent bond made by the sharing of two pairs of electrons.
Unsaturated hydrocarbon	A hydrocarbon whose molecule contains at least one carbon-carbon double bond.
Alkene	A **hydrocarbon** containing at least one **double bond**. They follow the formula $\mathbf{C_nH_{2n}}$. Used to make **polymers**.
Bromine water	A chemical that is **brown/orange** in colour. If added to an **alkene** it reacts and changes to **colourless**. Alkanes do not produce a change in colour.
Addition	two molecules add together to form a single product with 100% atom economy.
Oxidising agent	A substance that has the ability to oxidise other substances. Its symbol is [O]

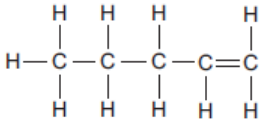
Section 2a: Structure of Alkenes

Alkenes are unsaturated hydrocarbons. The general formula of the alkenes containing one double bond is $\mathbf{C_nH_{2n}}$


Ethene

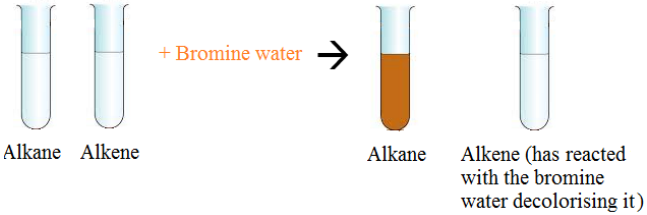
Propene


Butene


Pentene

Section2b: Reactions of the alkenes

It is the **C=C double bond** that makes the **alkenes far more reactive than the alkanes**. Alkenes will react with hydrogen, water (steam) and the halogens, by addition of atoms across the C=C double bond so that the double bond becomes a single carbon-carbon bond.

Combustion	Alkenes will burn in oxygen to produce carbon dioxide and water. $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ **Alkenes release less energy** per mole in combustion **than alkanes** hence the **alkanes tend to be used as fuels**, whereas the alkenes are not.
Reaction with halogens	Ethene reacts with bromine to form dibromoethane in an **addition** reaction. $CH_2=CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$ When you test ethene with **orange bromine water** it turns the bromine water from orange to colourless.  The alkenes also react in a similar way with the other halogens, chlorine and iodine.
Reaction with hydrogen	Alkenes **reacts with hydrogen** in the presence of a **nickel catalyst** at a temperature of about 150°C to **produce an alkane**. $C_2H_4 + H_2 \rightarrow C_2H_6$ This reaction is used to add hydrogen across double bonds in unsaturated oils making margarine.
Reaction with water (steam)	Ethene **reacts with steam** in the presence of a **catalyst** to make ethanol. $C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$ The reaction also requires heat and high pressure. The reaction is **reversible** so unreacted steam and ethane are recycled over the catalyst.

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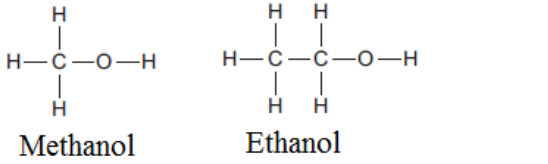
Section 3a : Structure of Alcohols

Alcohols contain the -OH functional group.



Section 3b: Reactions of the alcohols

Combustion	Alcohols are **flammable** and will burn in oxygen with a **clean blue flame** to produce **carbon dioxide** and **water**. $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$
With sodium	React with sodium metal to produce a solution **of sodium alkoxide and hydrogen gas.** $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$ If sodium ethoxide, or any other sodium alkoxide is dissolved in water, **effervescence (bubbles)** are observed and you get a **strongly alkaline solution**.
Oxidation	Combustion is one way to oxidise an alcohol, however you can also oxide an alcohol using an **oxidizing agent** such as **potassium dichromate**. An alcohol is oxidized to a **carboxylic acid** when boiled with **acidified** potassium dichromate. $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$
With water	Alcohols dissolve many of the same substances as water. They also dissolves some organic compounds that water cannot, making them **excellent solvents**. The first four alcohols dissolve well with water making a neutral solution.

Section 3c: Uses of alcohols

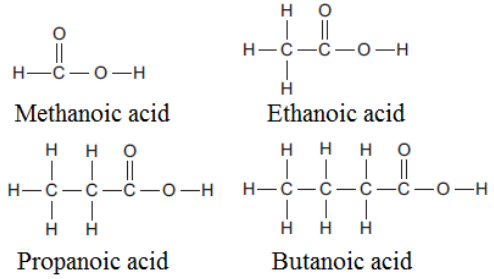
Alcohols are used as solvents in products such as perfumes, aftershaves and mouthwashes. Ethanol is the main alcohol in alcoholic drinks. Ethanol is also used in spirit burners and as a fuel, for e.g. as a biofuel in cars.

Section 3d: Manufacture of ethanol

Fermentation	Ethanol is made by **fermenting sugars** from plant material with **yeast**. The reaction is typically carried out between **20-30˚C**. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ All equipment must be **sterile** at the start. It also has to be carried out under **anaerobic (without air)** conditions, otherwise the ethanol would react with oxygen and turn into vinegar. Ethanol made by fermentation is termed a **biofuel.**
From ethene	Ethanol can also be made from reacting ethene (obtained from cracking of crude oil) and steam in the presence of a catalyst. This method uses up crude oil, a non renewable resource.

Section 4a : Structure of Carboxylic acids

Carboxylic acids contain the -COOH functional group.



Section 4b : Reactions of Carboxylic acids

With metal carbonates	Forms a salt, water and carbon dioxide $2CH_3COOH + Na_2CO_3 \rightleftharpoons 2CH_3COONa + H_2O + CO_2$ Effervescence (bubbles) observed as $CO_{2(g)}$ forms
In water (HT)	Aqueous solutions of carboxylic acids are **weak acids** & only **partially ionise** (have higher pH than strong acids of same concentration). $CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$
With alcohols	**Esters** are formed. **A sulfuric acid catalyst** is required. $CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$ In this reaction, the ester **ethyl ethanoate** forms. Esters are **sweet/fruity smelling** & used in perfumes & food flavourings.