

# WJEC Chemistry A-Level

## C3.3: Halogenoalkanes

Detailed Notes

English Specification

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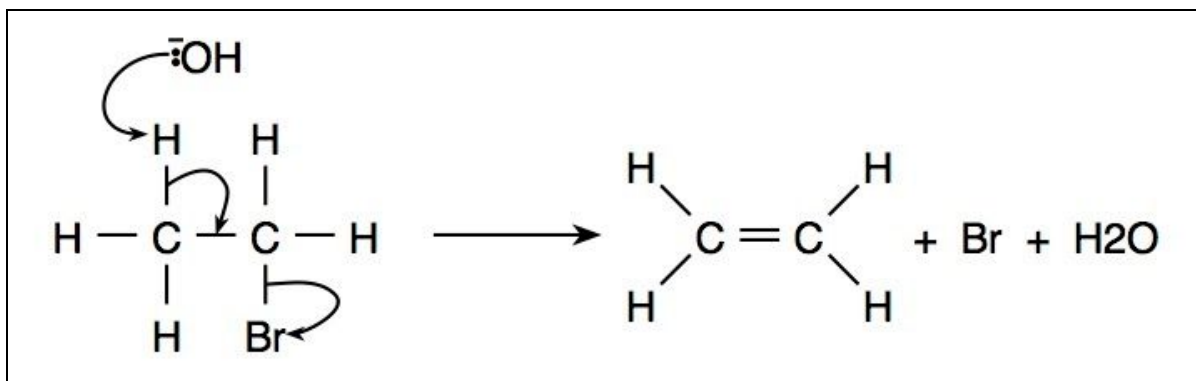




## Elimination Reactions

When a halogenoalkane is mixed with hydroxide ions and heated to **high temperatures** under **alcoholic** conditions, **elimination** occurs. In this reaction, a hydroxide ion **nucleophile** acts as a base and accepts a proton, removing a hydrogen atom from the molecule. This results in the elimination of the **halide** too, producing a **carbon-carbon double bond**.

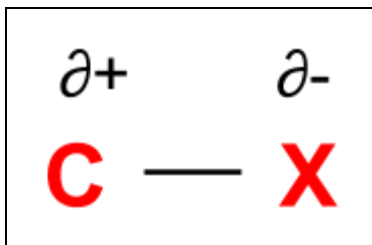
### Mechanism - elimination



## Nucleophilic Substitution

Halogenoalkanes contain **polar bonds** as the halogens are much **more electronegative** than carbon atoms. This means electron density is drawn towards the halogen, forming  $\delta^+$  and  $\delta^-$  regions.

Example:

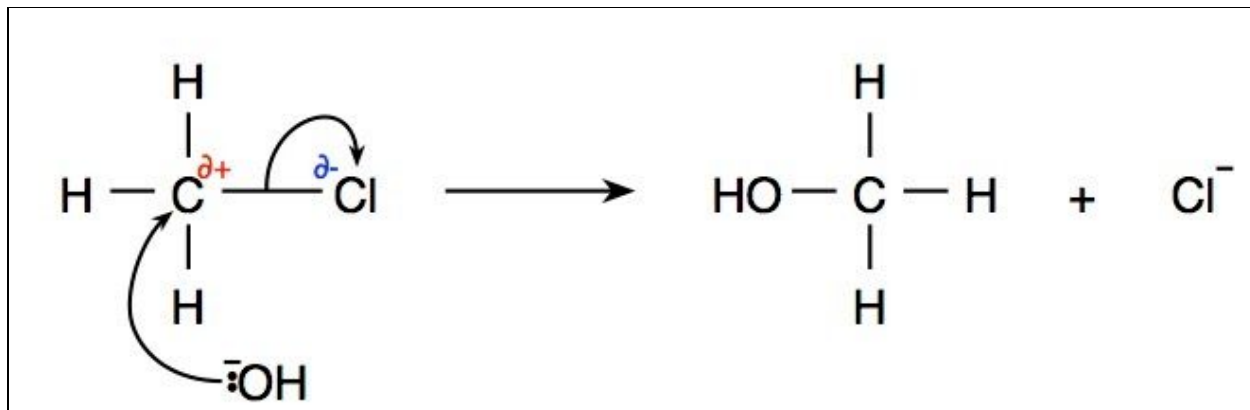


In the reaction mechanism of **nucleophilic substitution**, nucleophiles attack the halogenoalkane and displace the halogen to produce compounds such as **alcohols** and **amines**.



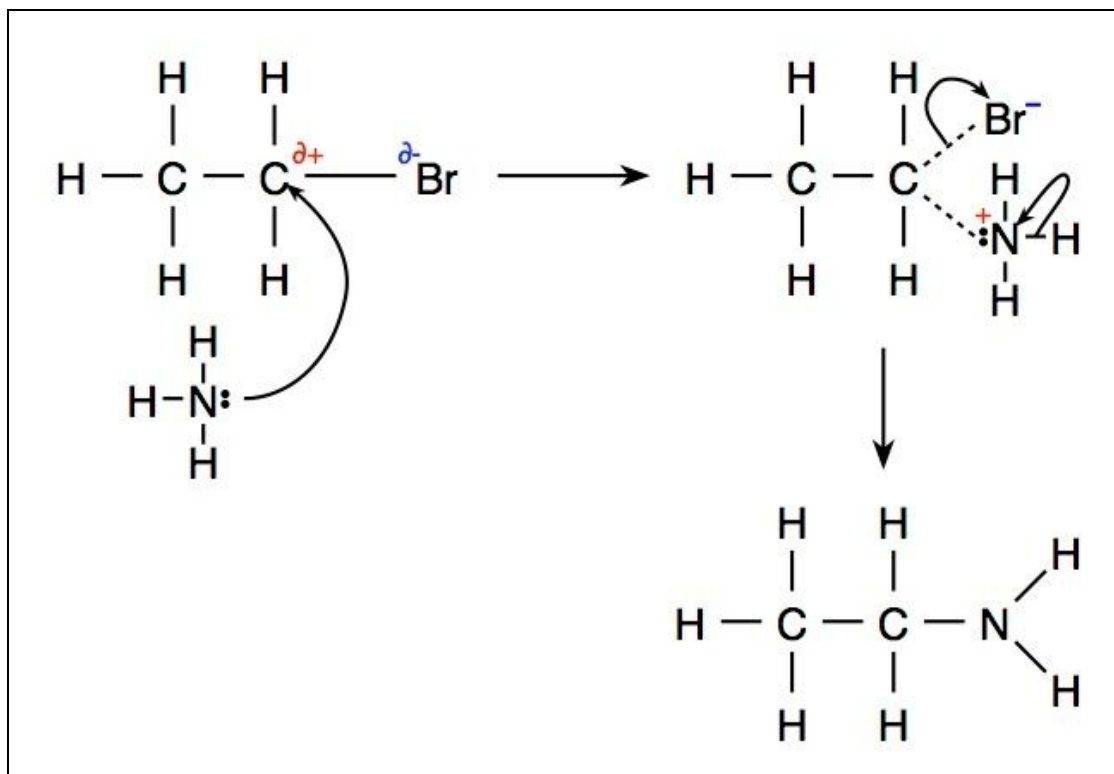


### Mechanism - nucleophilic substitution of a halogenoalkane to form an alcohol



The nucleophile attacks the  $\delta^+$  carbon and the electrons are transferred to the chlorine.

### Mechanism - nucleophilic substitution of a halogenoalkane to form an amine



The intermediate formed has an  $N^+$  atom, so electrons are transferred to it causing a hydrogen to be lost.

The greater the **relative atomic mass of the halogen** in the polar bond, the lower the **bond enthalpy**. The lower the bond enthalpy, the more easily the bond can be broken. Therefore, the



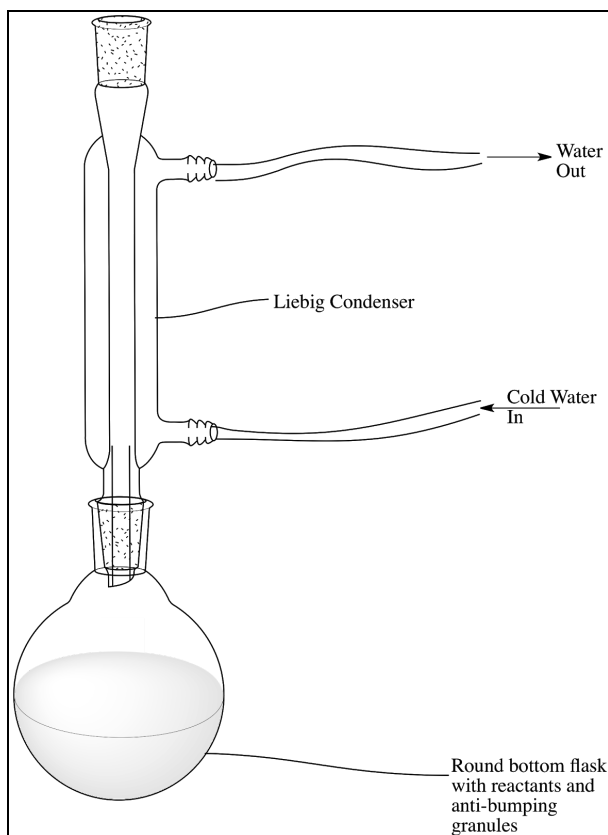


higher the relative atomic mass of the halogen atom, the faster the **rate of reaction** for the halogenoalkane.

## Reflux

The process of nucleophilic substitution has to be carried out under **reflux conditions** in a **closed system**. In reflux, the vapours of the reaction evaporate, condense and return to the original solution to be heated again.

There is specific **reflux equipment** that can be used to carry out this process, including a **Liebig condenser** and **anti-bumping granules** that help to disperse the heat evenly through the solution.



## Testing for Halogenoalkanes

To test for halogenoalkanes, the unknown solution should be **warmed** with a mixture of **sodium hydroxide, ethanol and water**. This is a **hydrolysis** reaction that causes the **displacement** of the halide ion. After the halide ion has been displaced, **dilute nitric acid** is added to the solution to neutralise any excess sodium hydroxide. The type of halide ion present can then be identified specifically by using **silver nitrate solution**. The  $\text{Ag}^+$  ions from silver nitrate react with the halide to produce **coloured precipitates**.





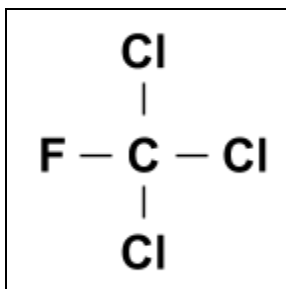
The precipitates formed may not be clear to distinguish so they can be tested further using **ammonia**.

	Cl <sup>-</sup>	Br <sup>-</sup>	I <sup>-</sup>
+ AgNO <sub>3</sub>	White precipitate (AgCl)	Cream precipitate (AgBr)	Yellow Precipitate (AgI)
+ dilute NH <sub>3</sub>	Precipitate dissolves	No Change	No Change
+ conc. NH <sub>3</sub>	Precipitate dissolves	Precipitate dissolves	No Change

## Uses of Halogenoalkanes

**CFCs (chlorofluorocarbons)** are halogenoalkane molecules where all of the hydrogen atoms have been replaced by **fluorine** and **chlorine** atoms.

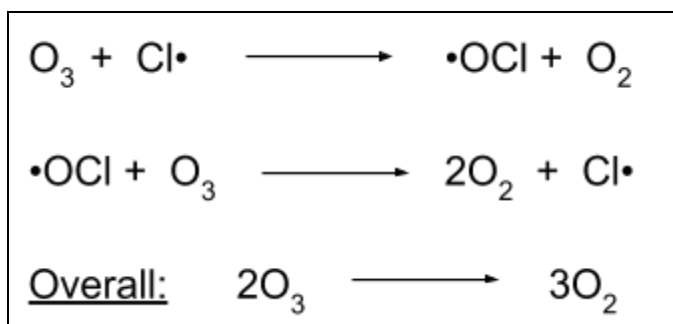
Example:



They are used for **refrigerants**, **foamed plastic** production, dry cleaning **solvents** and **aerosols** due to their low flammability and toxicity.

However, once released into the atmosphere, CFCs **absorb UV radiation** causing them to break down to form **free radicals**. These free radicals are very harmful to the environment because they can **catalyse ozone depletion**.

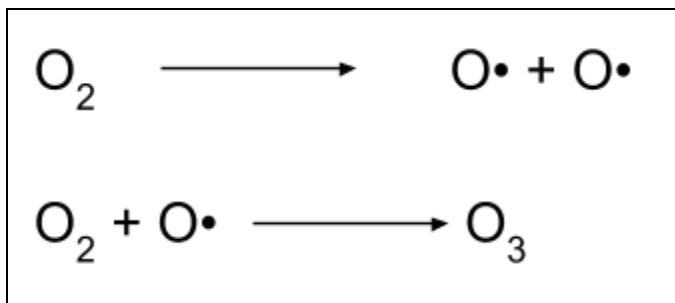
Example:





**Ozone**,  $O_3$ , is in the upper atmosphere and helps to **prevent ultraviolet radiation** from the sun from reaching the earth. Ultraviolet radiation causes **sunburn** and skin cancer so ozone is a very important layer of protection.

Ozone is formed from **oxygen free radicals**:



**CFC-free** solvents are now being produced to prevent the damage to the ozone layer.

