AQA Chemistry A-level

3.3.3: Halogenoalkanes

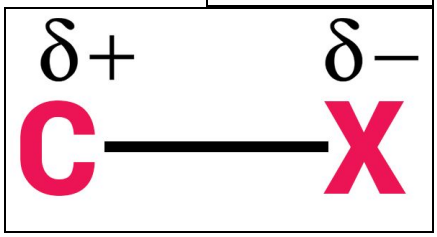
Detailed Notes

3.3.3.1 - Nucleophilic Substitution

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

Example:

Image courtesy of byjus.com



Nucleophiles

These species are **'positive liking'**. They contain a lone electron pair that is attracted to ∂+ regions of molecules. Some of the most common nucleophiles are:

- $CN:^-$
- $:NH_3$
- $^-:OH$

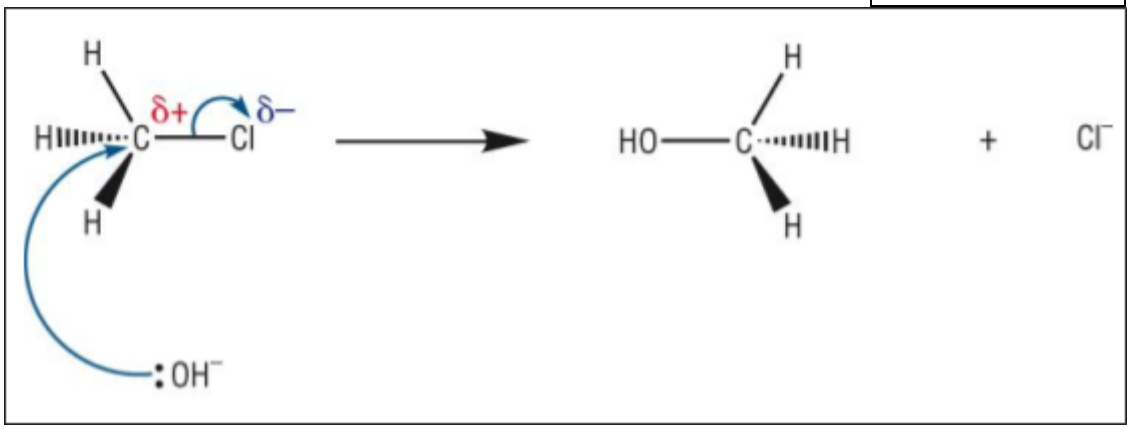
They must be shown with the **lone electron pair and often a negative sign** indicating they are nucleophiles.

Nucleophilic Substitution

This is the reaction mechanism that shows how nucleophiles attack halogenoalkanes. It can be used to produce **alcohols or amines** from halogenoalkanes.

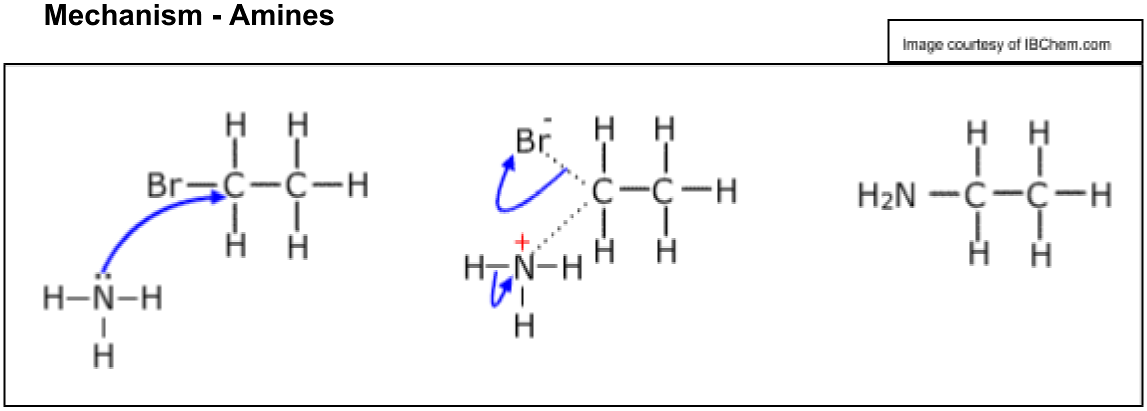
Mechanism - Alcohol

Image courtesy of GoogleSite



The nucleophile attacks the ∂+ carbon and the electrons are transferred to the chlorine.

Mechanism - Amines



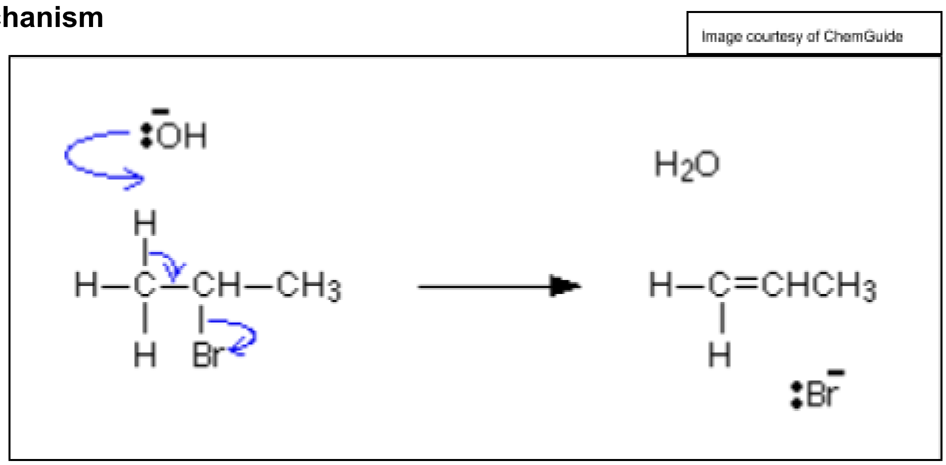
The intermediate formed has an N^+ atom, so electrons are transferred to it causing a hydrogen to be lost too.

The **greater the Mr** of the halogen in the polar bond, the **lower the bond enthalpy** meaning it can be broken more easily. Therefore the rate of reaction for these halogenoalkanes is faster. Nucleophilic substitution reactions can only occur for **1° (primary) and 2° (secondary**) halogenoalkanes.

3.3.3.2 - Elimination

When a halogenoalkane is heated to **high temperatures** under **alcoholic** conditions, **elimination** occurs. In this reaction, the 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**, an alkene.

Mechanism



Elimination reactions can only occur from **2° and 3° (tertiary)** halogenoalkanes.

3.3.3.3 - Ozone Depletion

Ozone in the atmosphere **absorbs UV radiation.** CFCs (chloro-fluoro carbons) also absorb UV radiation, breaking down the carbon-halogen bonds to form **free radicals** that can catalyse ozone depletion.

Example:

$$O_3 + Cl\bullet \longrightarrow \bullet OCl + O_2$$

$$\bullet OCl + O_3 \longrightarrow 2O_2 + Cl\bullet$$

$$\underline{\text{Overall:}} \quad 2O_3 \longrightarrow 3O_2$$

CFC-free solvents are now being produced to prevent them entering the atmosphere. This helps **minimise ozone depletion and global warming**.