

HALOGENOALKANES

Y12 - Team 2

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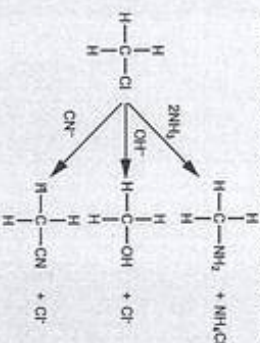
DIPOLE

Carbon-halogen bonds have a dipole due to the difference in electronegativity between the carbon and the halogen.



This means that the carbon is slightly positively charged, and so attracts nucleophiles.

NH_3 , OH^- and CN^- can all act as nucleophiles.



NUCLEOPHILES

Nucleophiles donate a pair of electrons in a reaction. They are attracted to positive / partially positive atoms.

NUCLEOPHILIC SUBSTITUTION

- 1 The nucleophile donates a lone pair of electrons to the partially positive carbon atom.
- 2 Electrons from the C-Cl bond move to the Cl atom.



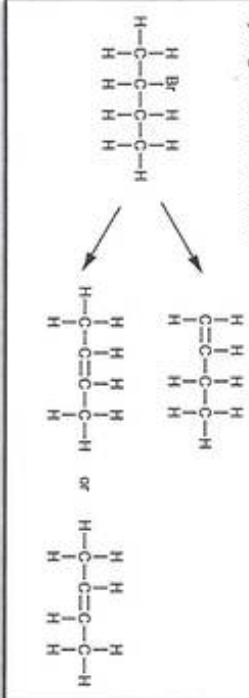
In the nucleophilic substitution mechanism, the nucleophile (Nu^-) substitutes the halogen atom on the halogenoalkane.

EXAM TIP

X is often used to represent the halogen.

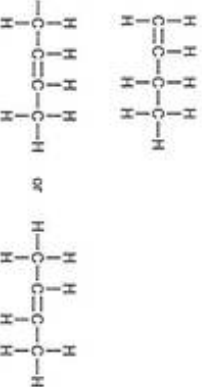
ELIMINATION

In the elimination mechanism, the hydroxide ion is acting as a base rather than a nucleophile because it is accepting a proton.



MULTIPLE PRODUCTS

Sometimes an elimination reaction will lead to multiple products, depending on which hydrogen atom is eliminated.



ELIMINATION VS SUBSTITUTION

EXAMPLE EQUATION

- When a haloalkane reacts with potassium hydroxide, two competing reactions occur:
1. **substitution**, where the halogen is substituted with a hydroxyl group
 2. **elimination**, where the halogen is removed and an alkene is formed
- Substitution (in water and ethanol)**
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{NaBr}$
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}=\text{CHCH}_3 + \text{NaBr} + \text{H}_2\text{O}$
- Elimination (in ethanol)**
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}=\text{CHCH}_3 + \text{NaBr} + \text{H}_2\text{O}$

OZONE DEPLETION

CFCs

CFCs, or chlorofluorocarbons, are a type of molecule which contains carbon, chlorine and fluorine atoms.

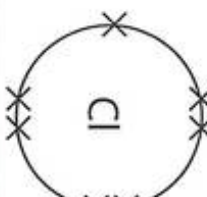
CFCs used to be used as refrigerants and solvents due to their low reactivity and low toxicity. It was eventually realised that they caused environmental damage because they cause ozone to break down.

Ozone in the ozone layer blocks harmful UV light from reaching the Earth's surface, and if the ozone layer breaks down, it will lead to problems caused by UV light, such as an increase in incidences of skin cancer and eye damage.

RADICALS

CFCs produce chlorine radicals when the C-Cl bond breaks due to UV light. Radicals are single atoms with an unpaired electron.

Here is the outer shell of electrons for a chlorine radical:



MECHANISM FOR THE BREAKDOWN OF OZONE

The mechanism for the breakdown of ozone has three steps.

- 1 $\text{CF}_2\text{Cl}_2 \xrightarrow{\text{UV}} \text{CF}_2\text{Cl} \cdot + \text{Cl} \cdot$
- 2 $\text{Cl} \cdot + \text{O}_3 \rightarrow \text{ClO} \cdot + \text{O}_2$
- 3 $\text{ClO} \cdot + \text{O}_3 \rightarrow \text{Cl} + 2\text{O}_2$

The formation of a $\text{Cl} \cdot$ radical from a CFC is caused by UV light.

The radical is reformed. The second and third steps are a cycle because $\text{Cl} \cdot$ is regenerated. One chlorine radical reacts many times in a chain reaction.

SCIENTIFIC RESPONSE



Scientists in different countries worked together to produce evidence that CFCs are harmful to the atmosphere. This led to governments banning the use of CFCs and replacing them with chlorine-free alternatives.

Despite being banned, CFCs can still be a problem in some places, as they last a long time in the atmosphere, in addition, some old CFC devices are still being used in some countries even though it is against the law, and CFCs released can travel over other countries' borders.