CIE Chemistry A-Level

Topic 16 - Halogen Derivatives

Flashcards

What are halogenoalkanes?

What are halogenoalkanes?

Halogenoalkanes are organic compounds where the hydrogen atom on an alkane has been replaced by a halogen.

How do halogenoalkanes undergo hydrolysis reactions?

How do halogenoalkanes undergo hydrolysis reactions?

$$CH_3CH_2Br + H_2O \rightarrow CH_3CH_2OH + HBr$$

- Reaction is fairly slow.
- Resulting solution can be tested with $AgNO_3$ to determine the halogen present.

How do halogenoalkanes undergo a nucleophilic substitution reaction to form a nitrile?

How do halogenoalkanes undergo a nucleophilic substitution reaction to form a nitrile?

$$CH_3CH_2Br + KCN \rightarrow CH_3CH_2CN + KBr$$

- Heat under reflux.
- Ethanol is used as the solvent.

How do halogenoalkanes react with ammonia to form a primary amine?

How do halogenoalkanes react with ammonia to form a primary amine?

First the halogenoalkane reacts with ammonia to form an alkyl ammonium salt:

$$CH_3CH_2Br + NH_3 \rightarrow CH_3CH_2NH_3Br$$

If the ammonia is in excess, the salt reacts to form a primary amine:

$$CH_3CH_2NH_3Br + NH_3 \rightarrow CH_3CH_2NH_2 + NH_4Br$$

How does 2-bromopropane react to form an alkene?

How does 2-bromopropane react to form an alkene?

Elimination reaction:

Reflux with KOH in ethanol (or conc. NaOH solution).

$$CH_3CHBrCH_3 + KOH \rightarrow CH_2{=}CHCH_3 + KBr + H_2O$$

Describe the S_N1 nucleophilic substitution mechanism

Describe the S_N1 nucleophilic substitution mechanism

E.g. $(CH_3)_3CCl + OH^- \rightarrow (CH_3)_3COH + Cl^-$

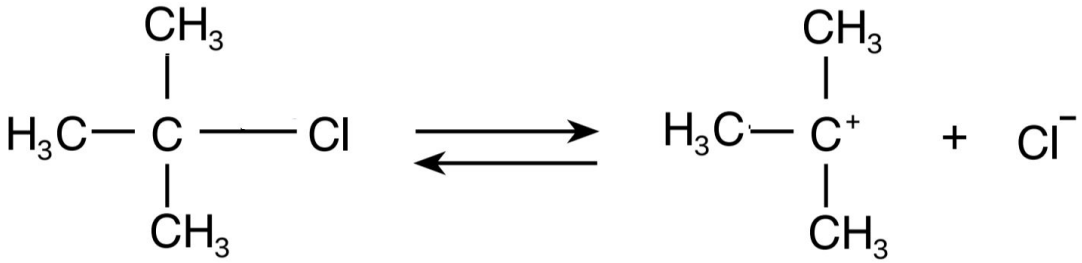
In the first stage, the halogenoalkane ionises to form the carbocation intermediate $(CH_3)_3C^+$ and Cl^-.

The $(CH_3)_3C^+$ intermediate then immediately reacts with the hydroxide ion to form the product.

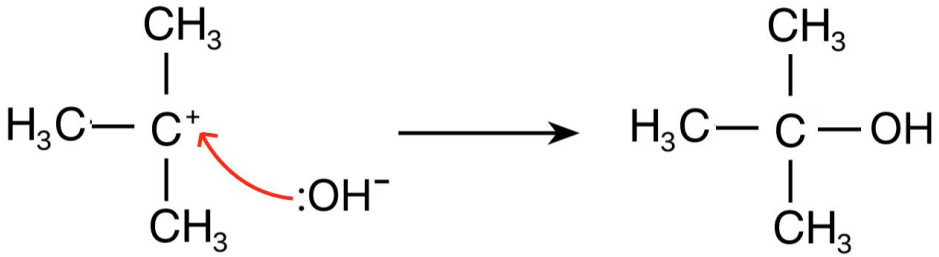
What does the S_N1 mechanism look like?

What does the S_N1 mechanism look like?

Step 1



Step 2



Describe the S_N2 nucleophilic substitution mechanism

Describe the S_N2 nucleophilic substitution mechanism

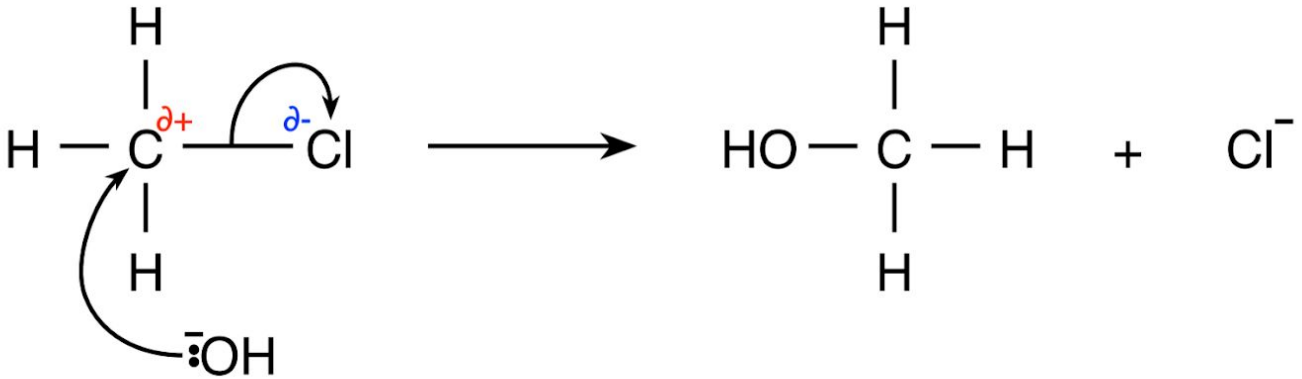
E.g. $CH_3CH_2Br + OH^- \rightarrow CH_3CH_2OH + Br^-$

- These reactions are a one step mechanism.
- The nucleophile attacks the substrate at the same time as the leaving group leaves the substrate.
- The nucleophile attacks the carbon atom from the back side, causing an inversion of the groups in the product.
- The nucleophile attacks from the backside because the large halogen atom prevents the attack from the other direction.

What does a S_N2 mechanism look like?

What does a S_N2 mechanism look like?

E.g. $CH_3Cl + OH^- \rightarrow CH_3OH + Cl^-$



What are the inductive effects of alkyl groups?

What are the inductive effects of alkyl groups?

Alkyl groups are electron-donating groups.

They push electrons away, making the alkyl group have a slight positive charge and the carbon it is bonded with to have a slight negative charge. This is called the positive inductive effect.

What mechanism (S_N1 or S_N2) do primary, secondary and tertiary haloalkanes react via?

What mechanism (S_N1 or S_N2) do primary, secondary and tertiary haloalkanes react via?

Primary halogenoalkanes tend to react via the S_N2 mechanism.

Tertiary halogenoalkanes tend to react via the S_N1 mechanism.

Secondary halogenoalkanes react via a mixture of the two, depending on the structure.

What are the relative strengths of carbon-halogen bonds?

What are the relative strengths of carbon-halogen bonds?

As you go down Group 7, the carbon-halogen bond strength decreases.

$$C\text{-}F > C\text{-}Cl > C\text{-}Br > C\text{-}I$$

Hence what is the trend in the rate of hydrolysis of carbon-halogen bonds?

Hence what is the trend in the rate of hydrolysis of carbon-halogen bonds?

As you go down the group, the rate of hydrolysis of carbon-halogen bonds increases as less energy is required to break the bond since bond strength weakens down the group.

What are the uses of fluoroalkanes and fluorohalogenoalkanes?

What are the uses of fluoroalkanes and fluorohalogenoalkanes?

- Refrigerants
- Used in aerosols
- Used in making foamed plastics

They are very chemically inert and will not react with anything.

What is the environmental problem with the use of CFCs (chlorofluorocarbons)?

What is the environmental problem with the use of CFCs (chlorofluorocarbons)?

CFCs damage the ozone layer. The ozone is in the upper atmosphere and it absorbs a lot of UV radiation.

CFCs are broken down by UV light, releasing a chlorine radical. This chlorine radical react with ozone and breaks it down to oxygen. This means there is less protection from UV radiation.

Give the equations for the reactions that take place between a chlorine free radical and ozone

Give the equations for the reactions that take place between a chlorine free radical and ozone

$$Cl\cdot + O_3 \rightarrow O_2 + ClO\cdot$$

$$ClO\cdot + O_3 \rightarrow 2O_2 + Cl\cdot$$

$$\text{Overall: } 2O_3 \rightarrow 3O_2$$