

Name: _____

Date: _____

AQA A-LEVEL CHEMISTRY

Nucleophilic Substitution: Mechanism, Reagents & Conditions

Learn Pack

This pack is designed to be completed alongside the video to help you build a secure understanding of this topic before moving on to revision and exam practice.

How to use this Learn Pack:

1. Watch the video and complete the activities.
 2. Answer the Fact Recall and Application questions.
 3. Check your work using the Learn Pack
- Answers available at mrcolescience.co.uk.

WATCH THE LESSON



Nucleophilic Substitution

Nucleophilic substitution reactions occur when a functional group within a molecule is substituted for another functional group by a nucleophile.

Nucleophiles are electron pair donors. They therefore will always have at least one lone pair of electrons.

Lesson Objectives:

- Describe what a nucleophile is and how to represent them in mechanisms.
- Outline the nucleophilic substitution mechanism for the reactions of halogenoalkanes with OH^- , CN^- and NH_3 .
- Know the reagents, conditions and products for the nucleophilic substitution of halogenoalkanes with OH^- , CN^- and NH_3 .

What are lone pairs of electrons and how are they represented?

Lone pairs of electrons are pairs of electrons that are not being used to form covalent bonds. They're represented by a pair of dots.

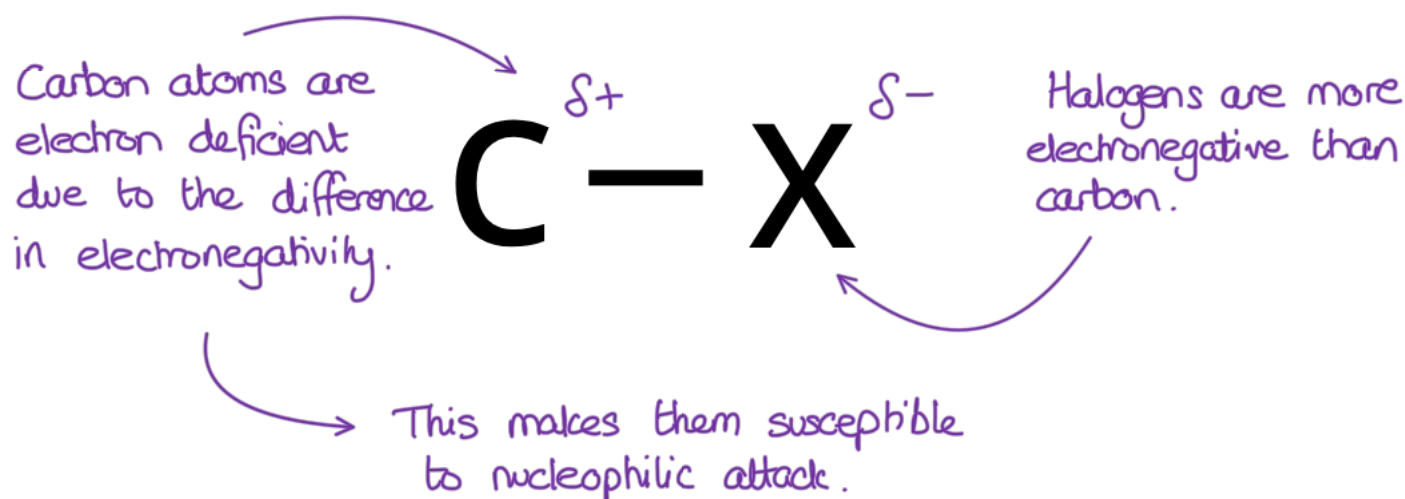
Define the term substitution in the context of nucleophilic substitution of halogenoalkanes:

The replacement of a halogen atom by a nucleophile.

Halogenoalkanes and Nucleophilic Substitution

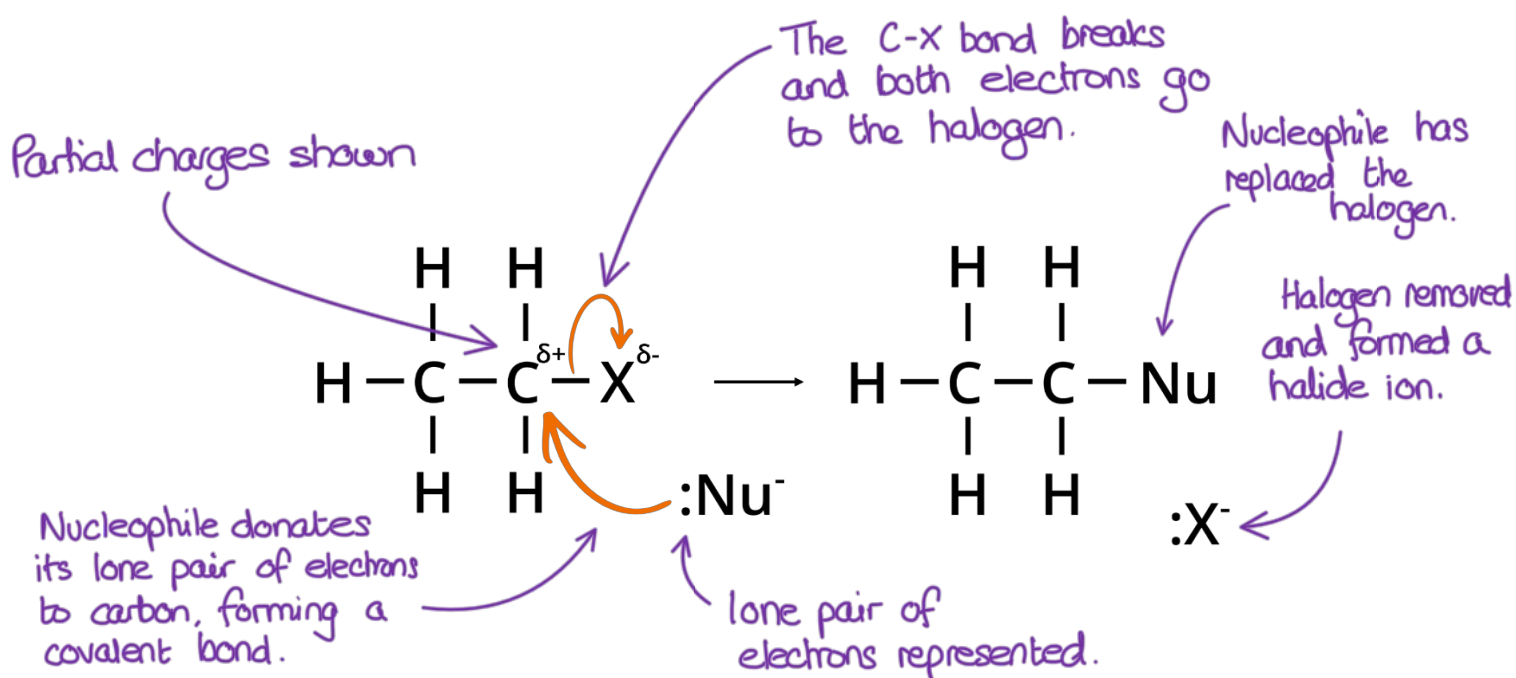
All halogenoalkanes contain a polar carbon-halogen bond due to the difference in electronegativity between the carbon atom and the halogen atom.

Annotate the diagram below to explain why halogenoalkanes can undergo nucleophilic substitution:



Nucleophilic Substitution Mechanism

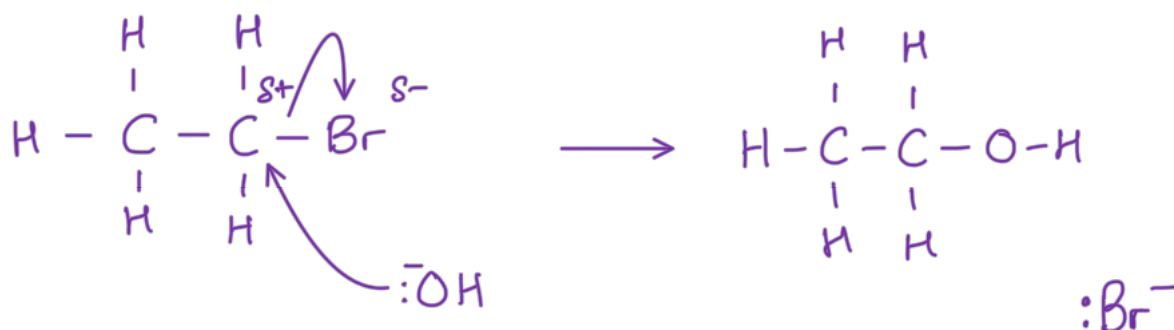
Annotate the mechanism below to explain what happens during nucleophilic substitution reactions:



Reactions of Halogenoalkanes with Hydroxide Ions (OH⁻)

Halogenoalkanes undergo nucleophilic substitution reactions with hydroxide ions to form alcohols. To do this the halogenoalkane needs to be reacted with warm, aqueous potassium or sodium hydroxide.

Draw the mechanism for the nucleophilic substitution of bromoethane with potassium hydroxide below:



Give an overall equation for this reaction:



Reactions of Halogenoalkanes with Cyanide Ions (CN⁻)

Halogenoalkanes undergo nucleophilic substitution reactions with cyanide ions to form nitriles. To do this the halogenoalkane needs to be reacted with ethanolic potassium or sodium cyanide and heated under reflux.

Why is potassium or sodium cyanide dissolved in an alcohol rather than water?

To prevent water from an aqueous solution acting as a nucleophile and forming an alcohol.

Draw the mechanism for the nucleophilic substitution of bromoethane with potassium cyanide below:



Give an overall equation for this reaction:



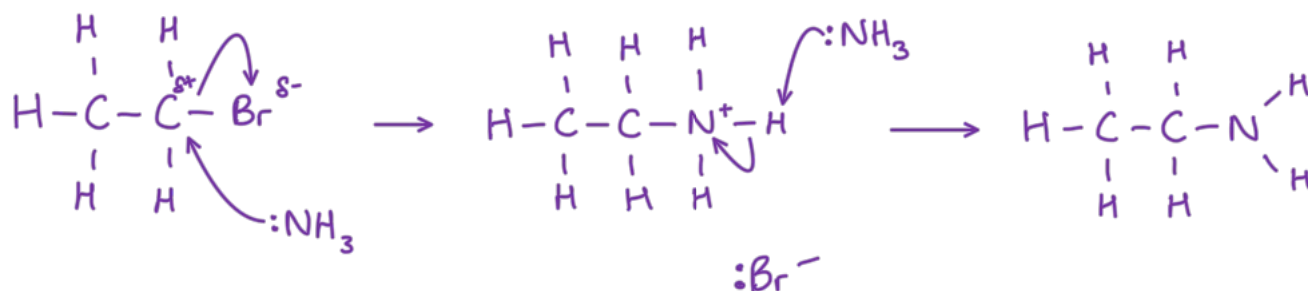
Reactions of Halogenoalkanes with Ammonia (NH₃)

Halogenoalkanes undergo nucleophilic substitution reactions with ammonia to form amines. To do this the halogenoalkane needs to be reacted with warm, excess ethanolic ammonia.

Why is an excess of ammonia required for this reaction?

To prevent further substitution and ensure a high yield of the primary amine.

Draw the mechanism for the nucleophilic substitution of bromoethane with ammonia below:



Give an overall equation for this reaction:



Practise Questions – Fact Recall

1. What is a nucleophile?

An electron pair donor

2. What happens during a nucleophilic substitution reaction?

A halogen atom is replaced by a nucleophile.

3. State the reagent and conditions required for the nucleophilic substitution of a halogenoalkane to form an alcohol.

Warm, aqueous potassium or sodium hydroxide

4. State the conditions required to react chloroethane with ammonia to form ethylamine.

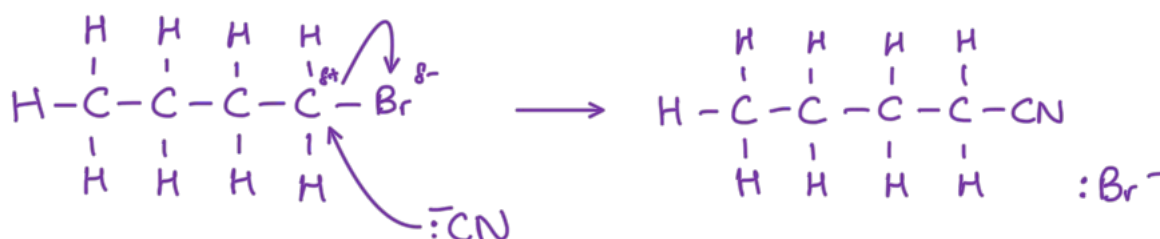
Excess ethanolic ammonia

5. What feature of halogenoalkanes makes them susceptible to nucleophilic substitution reactions?

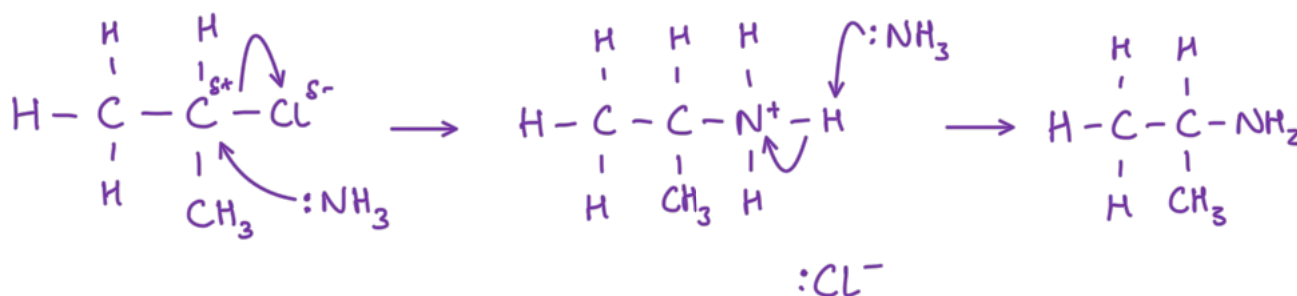
The polar carbon-halogen bond.

Practise Questions – Application

1. Draw the reaction mechanism for the reaction of 1-bromobutane with warm ethanolic potassium cyanide.



2. Draw the reaction mechanism for the reaction between 2-chloropropane and excess warm ethanolic ammonia.



Next Steps

Check your work using the Learn Pack Answers:

