Mr Cole Science

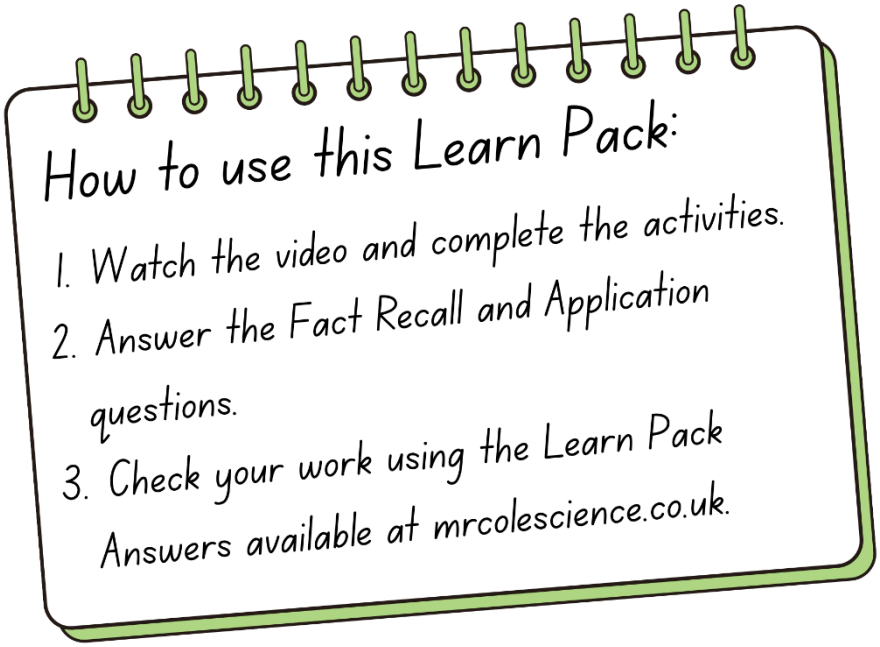
Name: _____ **Date:** _____

AQA A-LEVEL CHEMISTRY

Free Radical Substitution: Synthesising Halogenoalkanes

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.



WATCH THE LESSON

Synthesis Halogenoalkanes

Halogenoalkanes are formed when one or more _____ atoms from an alkane are _____ for a halogen atom.

Halogenoalkanes are formed during a _____ _____ reaction.

Lesson Objectives:

- Know what a free radical is and how it is represented.
- Know that the reaction of an alkane with a halogen occurs via a free-radical substitution mechanism.
- Be able to outline the stages involved in a free radical substitution reaction.
- Be able to write balanced equations for the stages in a free radical substitution mechanism.

Free Radicals

A free radical is an atom, ion or molecule that has at least one unpaired electron. Free radicals are formed when a covalent bond splits homolytically.

Annotate the diagram below to explain what happens when a covalent bond splits homolytically:

The unpaired electron makes free radicals highly reactive, so reactive that they are able to react with relatively unreactive alkane molecules via a free radical substitution reaction.

Free Radical Substitution

Reaction mechanisms show how it is that molecules react. They illustrate or explain what is happening during each stage of the reaction, ultimately showing how the products are formed.

The mechanism for free-radical substitution reactions uses a series of equations to illustrate what goes on during three stages of the reaction:

1.

2.

3.

Initiation

The initiation step involves the homolytic breaking of the halogen-halogen covalent bond to form two halogen free radicals.

→

Identify the essential condition required for this reaction and explain why it is needed:

Propagation

During propagation two different reactions occur. Firstly, the halogen free radical produced during initiation reacts with an alkane, producing an alkyl free radical and a hydrogen halide:

+ → +

Secondly, the alkyl free radical produced during that first propagation step reacts with a halogen molecule, forming a halogenoalkane but also reforming a halogen free radical:

+ → +

Explain why this stage is called propagation:

Termination

This is where free radicals are removed and this can happen in one of three ways:

1. Two halogen free radicals reacting: →
2. A halogen free radical reacting with an alkyl free radical: →
3. Two alkyl free radicals reacting: →

Further Substitution

If the halogen is in excess, then further substitution reactions are likely to occur, meaning more than one halogen atom from the starting substance will be swapped out and replaced with a halogen:

$$CH_4 + 3Br_2 \rightarrow CHBr_3 + 3HBr$$

In A-Level Chemistry you are always expected to provide balanced symbol equations.

Explain the easy way to balance overall equations for free radical substitution reactions:

It's important to note that these further substitutions don't all occur at the same time. This means that it's not only alkanes that can undergo free radical substitution reactions with halogens; halogenoalkanes can undergo them too.

Explain how this affects each stage in the reaction below:

Initiation:

Propagation:

Termination:

Practise Questions – Fact Recall

1. What is a free radical?

2. How are free radicals represented?

3. State the essential condition required for free radical substitution.

4. What are the three stages, in order, for a free radical substitution reaction.

5. What happens during a termination step?

Practise Questions – Application

1. Write two equations to show what happens during the propagation stage for chloromethane reacting to form dichloromethane:

2. Write an initiation equation for bromomethane reacting to form bromofluoromethane:

Next Steps

Check your work using the Learn Pack Answers: