Edexcel International AS Chemistry

Your notes

Organic Chemistry: Introduction

Contents

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Types of Reaction

- Reactions can be classified as:
  - Addition
  - Elimination
  - Substitution
  - Oxidation
  - Reduction
  - Hydrolysis
  - Polymerisation

Addition reactions

- These involve two reactants combining to form one product
- The most common example of an addition reaction involves alkenes, e.g.

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

Elimination reactions

- These are usually identified by one or two reactants forming more products
  - The products often include an alkene and a smaller molecule that has been eliminated from the reactant, e.g.

$$CH_3CH_2Br + OH^- \xrightarrow{H^+} C_2H_4 + H_2O + Br^-$$

Substitution reactions

- An atom or group of atoms in a compounds is replaced by another atom or group of atoms, e.g.

$$CH_3CH_2Br + OH^- \rightarrow C_2H_5OH + Br^-$$

Oxidation reactions

- This can involve the loss of hydrogen or the gain of oxygen
- A reactant is oxidised by another chemical species, usually an inorganic reagent, e.g.

$$CH_3CHO + [O] \rightarrow CH_3COOH$$

- In this example, the oxidising agent [O] could be acidified potassium dichromate(VI) solution, Fehling's solution or Tollens' reagent

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Reduction reactions

- This can involve the gain of hydrogen or the loss of oxygen
- A reactant is reduced by another chemical species
  - This can often be completed using a catalyst and a small reactant molecule such as H_2 or HCl, e.g.

$$CH_3CHO + [H] \rightarrow CH_3CH_2OH$$

- In this example, the oxidising agent [H] could be lithium aluminium hydride

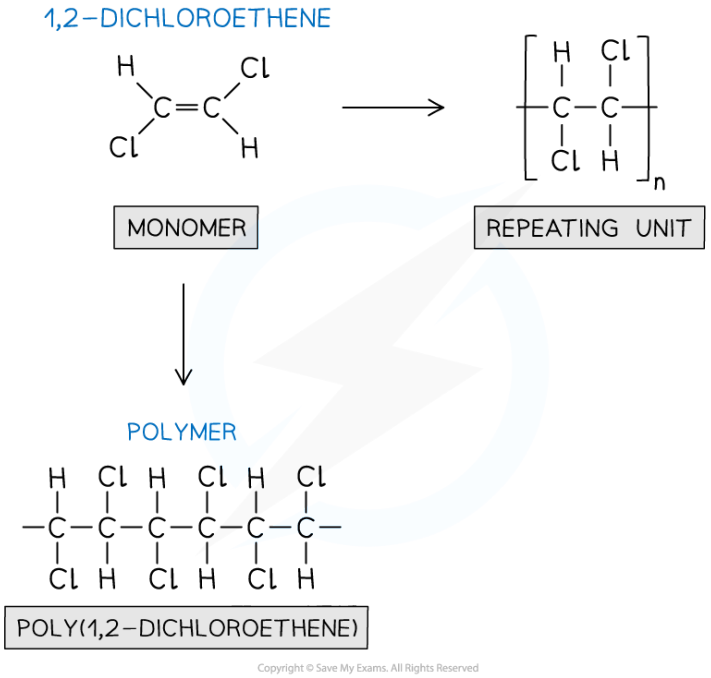
Hydrolysis reactions

- The name can be misleading as hydrolysis suggests that water is being used to split (or lyse) a compound
- Hydrolysis reactions are a specific reaction with water, e.g.

$$CH_3Cl + H_2O \rightarrow CH_3OH + HCl$$

Polymerisation reactions

- At AS level, you should know about **addition polymerisation**
- This is where the carbon-carbon double bond of an alkene monomer breaks open and forms a polymer chain, e.g.



Addition polymerisation of one alkene monomer is polymerised, a (poly)alkene is formed

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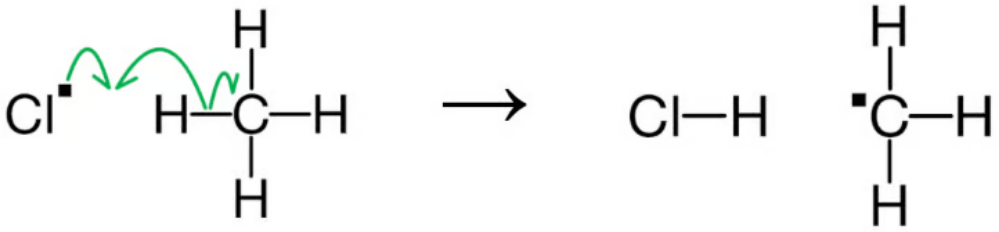
Reaction Mechanisms – Introduction

- Reaction equations tell you about the amount of reactants and products, including their stoichiometry, in a reaction
- Reaction mechanisms tell you about how the reaction actually takes place
- In a reaction mechanism, curly arrows show the movement of electrons
  - Curly arrows can be single headed, sometimes called fish-hook arrows or half curly arrows, to show the movement of one electron which can occur when:
    - A covalent bond undergoes **homolytic fission** to form two radicals
    - Two radicals **terminate** forming a covalent bond in the process
    - A radical and a covalent compound **propagate** as part of a reaction, as shown:

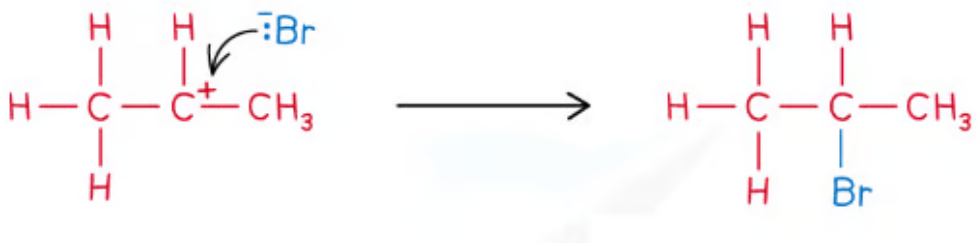


During this propagation step, the unpaired electron from chlorine and one of the electrons from the C-H bond react together to form a new covalent bond and the other electron from the C-H bond moves to form a methyl radical

Examiner Tips and Tricks

The use of single headed arrows is not required knowledge Their main use is in free radical reactions which are usually represented using written equations rather than outlined mechanisms

- Curly arrows can be double headed to show the movement of a pair of electrons, which can occur when:
  - A covalent bond undergoes fission to form a positive and a negative ion
  - The positive ion is electron deficient and is an electrophile
  - The negative ion is electron rich and is a nucleophile
  - A lone pair of electrons attacks a positive or δ+ centre and forms a new covalent bond, as shown:



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During this step of an addition reaction, the lone pair from the bromide ion reacts with the positive carbocation to form a new covalent bond

- Curly arrows are a feature of three main types of reaction:
  1. **Addition** reactions - where two reactants combine to form one product, e.g. ethene and bromine undergoing addition to form 1,2-dibromoethane
  2. **Substitution** reactions - where an atom or group of atoms in a compounds is replaced by another atom or group of atoms, e.g. bromoethane reacting with the hydroxide ion to form ethanol and the bromide ion
  3. **Elimination** reactions - where a small molecule is removed from a larger molecule, e.g. ethanol reacting with an acid catalyst to form ethene alongside a small molecule of water which is eliminated

Bond Polarity & Mechanisms

- Bond polarity can be used to suggest reaction mechanisms

$$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$$

- A hydrogen atom in ethane is **substituted** by a chlorine atom
  - All of the bonds in the reaction of ethane with chlorine are either **non-polar** or only slightly polar
  - This suggests that the type of bond breaking will be **homolytic** fission
  - The reaction is likely to involve **free radicals**
  - Therefore, the reaction mechanism is likely to be **free radical substitution**

$$C_2H_4 + HBr \rightarrow C_2H_5Br$$

- The hydrogen bromide is **added** to the ethene molecule
  - The hydrogen bromide molecule contains a **polar** bond
  - This suggests that the type of bond breaking will be **heterolytic** fission
  - The reaction could involve **electrophiles** or **nucleophiles**
  - The ethene molecule contains a **carbon-carbon double bond** which will attract an electrophile
  - Therefore, the reaction mechanism is most likely to be **electrophilic addition**

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