Cambridge (CIE) A Level Chemistry

Your notes

Addition Polymerisation

Contents

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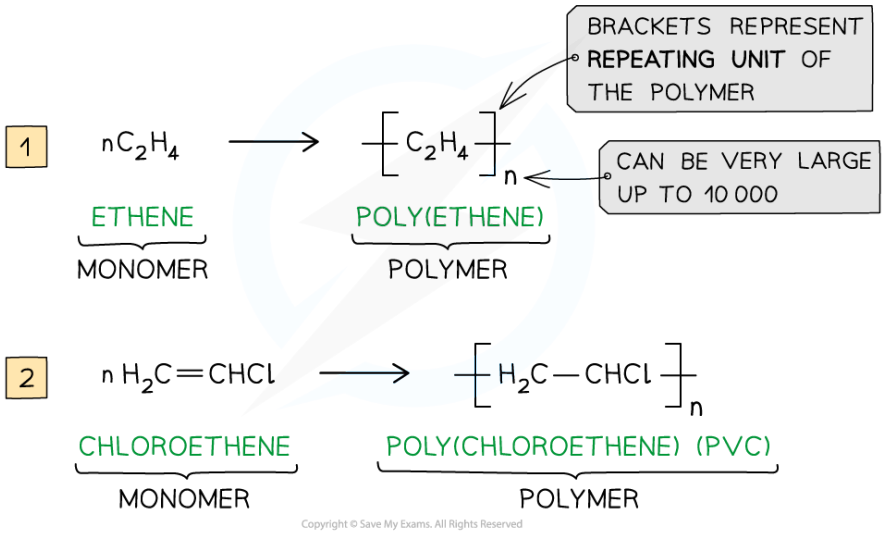
Addition Polymerisation: Polythene & PVC

Addition polymerisation

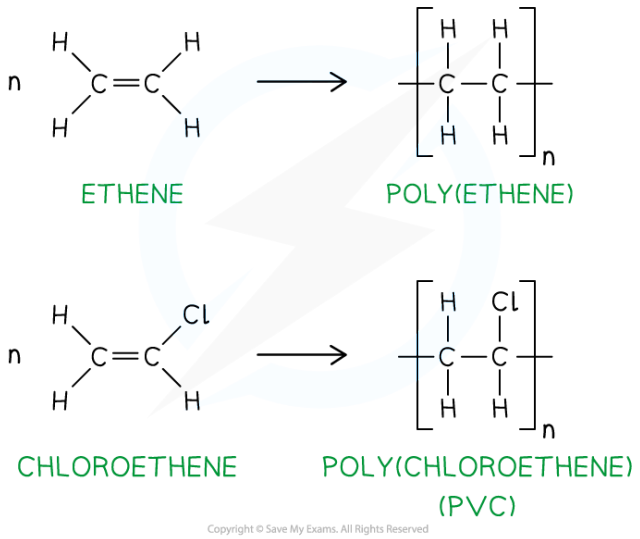
- **Addition polymerisation** is one of the most important addition reactions of alkenes which form the basis of the plastic industry
- Addition polymerisation is the reaction in which many **monomers** containing at least one C-C double bond form long chains of **polymers** as the only product
  - Just like in other addition reactions of alkenes, the π-bond in each C-C bond breaks and then the monomers link together to form new C-C single bonds
- A **polymer** is a long-chain molecule that is made up of many repeating units
- The small, reactive molecules that react together to form the polymer are called **monomers**
- A polymerisation reaction can be represented by a **general formula** or by using **displayed formulae**
  - E.g. poly(ethene) and poly(chloroethene) (also known as **PVC**) are polymers made up of the ethene and chloroethene monomers respectively and are commonly used in making plastics

General formula addition polymerisation



The general formulae of the addition polymerisation of ethene (1) and chloroethene (2)

Displayed formula addition polymerisation



The displayed formulae of the addition polymerisation of ethene (1) and chloroethene (2)

- Just like any other **addition** reaction of alkenes, addition polymerisation gives only **one** product

Deducing repeat units

- A **repeat unit** is the smallest group of atoms that when connected one after the other make up the polymer chain
  - It is represented by **square brackets** in the displayed and general formula
- In **poly(alkenes)** (such as poly(ethene)) and **substituted poly(alkenes)** (such as PVC) made of **one type of monomer** the repeating unit is the same as the monomer except that the C-C double bond is changed to a C-C single bond

Repeat units in polymers

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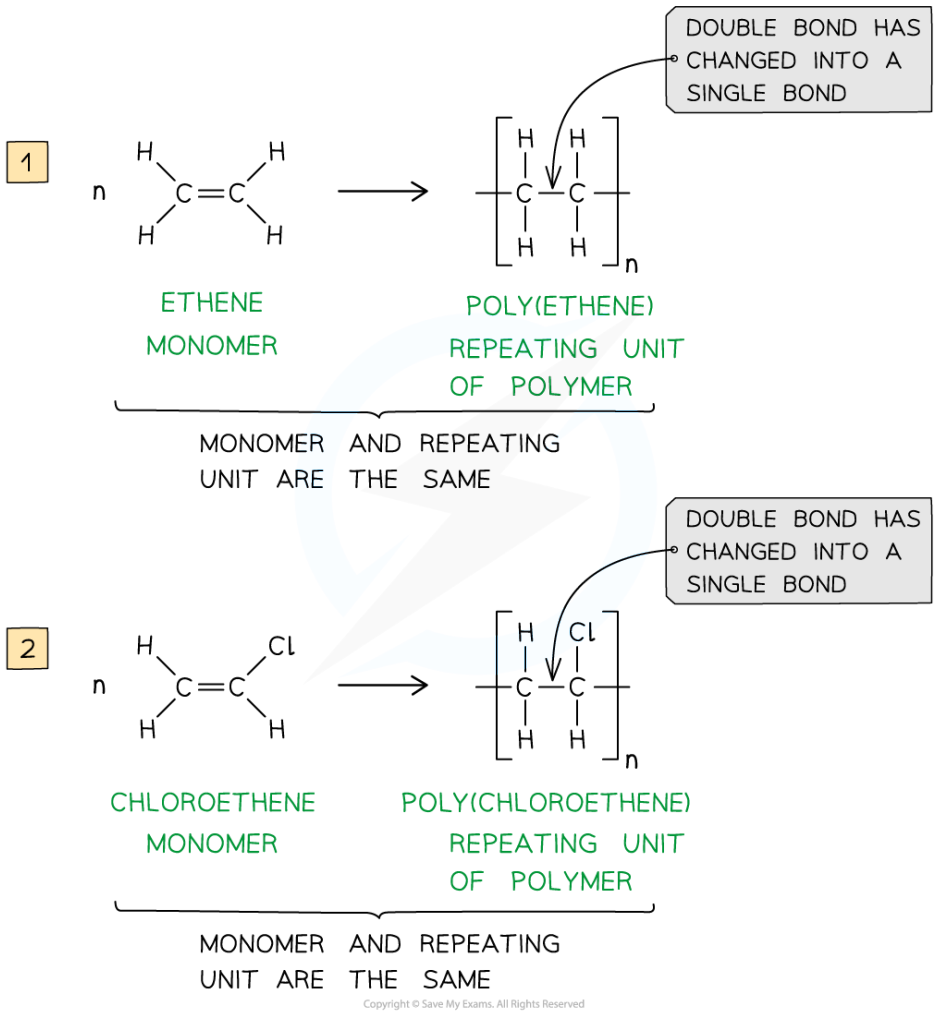

The repeating units of poly(ethene) and poly(chloroethene) are similar to their monomer except that the C=C bond has changed into a C-C bond

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Worked Example

Identify the monomers present in the given sections of addition polymer molecules:

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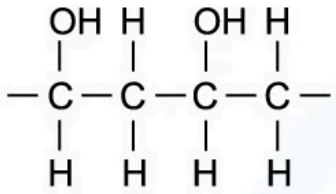
1.



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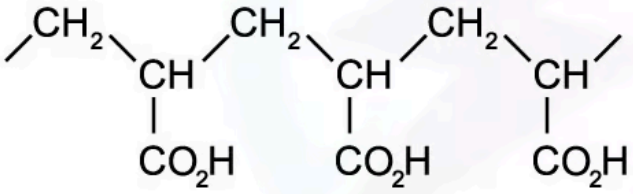
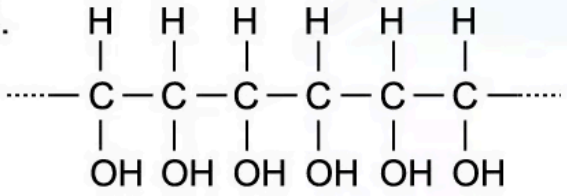
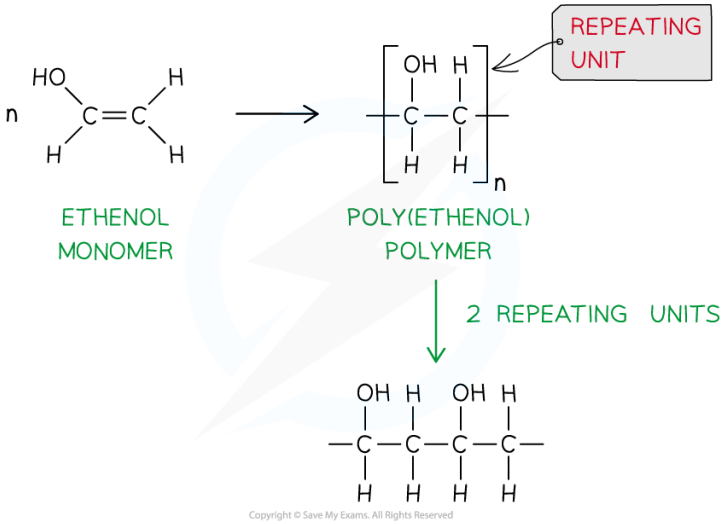


3.



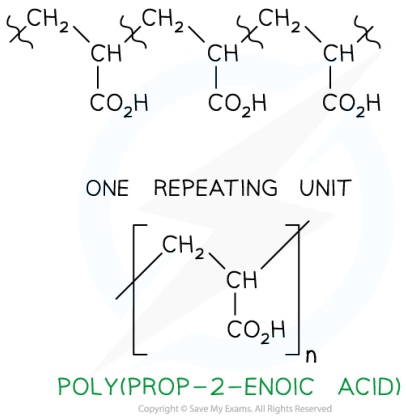
Answer 1:

- When ethenol ($CH(OH)=CH_2$) is polymerised, the C-C double bond opens to produce a repeating unit of $CH(OH)-CH_2$.
- This gives the polymer poly(ethenol)

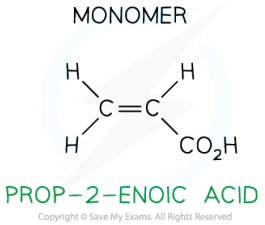


Answer 2:

- To find the monomer, first the repeating unit should be deduced
- Repeating units have only 2 carbons in the polymer main chain

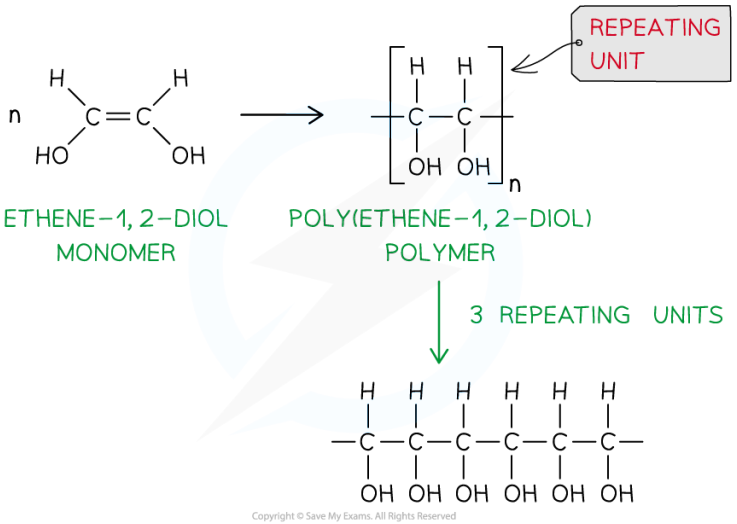


- Since the repeating unit is now found, it can be concluded that the monomer is prop-2-enoic acid



Answer 3:

- Again, the repeating unit only has 2 carbons in the polymer chain which in this case are two carbon atoms that each contain one OH group
- Thus, when ethene-1,2-diol (CH(OH)=CH(OH)) is polymerised, the C-C double bond opens to produce a repeating unit of CH(OH)-CH(OH) which gives the polymer poly(ethene-1,2-diol)



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Examiner Tips and Tricks

The section of the polymer chain shown inside the square brackets by the structural or displayed formula is the **repeat unit** and **not** the monomer

The monomer is the same as the repeat unit except for that it has C=C bonds instead of C-C bonds

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Disposal of Polymers

- Poly(alkenes) are extremely important in everyday life, such as their use as **plastics**
- However, the disposal of these polymers is problematic
- Poly(alkenes) are very large alkane molecules which are **unreactive** and therefore do not undergo any chemical reactions; they are **resistant** to **chemical attack**
- Due to their unreactivity, polymers are **non-biodegradable** and take up to hundreds of years to decompose when dumped in landfill sites
  - Throwing away poly(alkenes) therefore causes long-term pollution of the environment
- Burning the polymers results in **harmful combustion products** which again cause the pollution of the environment

Examiner Tips and Tricks

The disposal of polymers is a challenge due to their unreactivity, their non-biodegradability, and the formation of harmful combustion products when burnt