

Addition polymerisation

4.7.3.1 · Organic chemistry · revision notes

How alkenes join together to make addition polymers such as poly(ethene) and poly(propene), how to draw the repeating unit from a monomer, and how to work back from a polymer to its monomer. GCSE Chemistry only. Expect drawing questions worth 1 to 3 marks and short explanations.

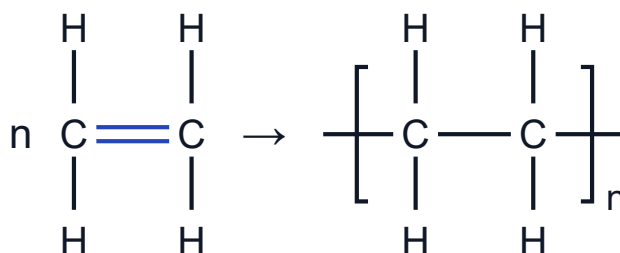
Key facts

- Monomer = small molecule; polymer = very large molecule made from many monomers
- Addition polymerisation: C=C opens to C–C; no other product
- $n \text{ CH}_2=\text{CH}_2 \rightarrow -(\text{CH}_2-\text{CH}_2)_n-$
- Repeating unit: 2 chain carbons, single bond, side groups, bonds through brackets, n
- Addition polymer monomers contain a C=C
- Repeating unit has the same atoms as the monomer
- Ethene $\rightarrow$ poly(ethene); propene $\rightarrow$ poly(propene)
- M_r of polymer = $n \times M_r$ of monomer

Notes

Monomers and polymers

- Polymers** are very large molecules made when many small molecules, called **monomers**, join together.
- In **addition polymerisation**, the monomers are alkenes (or other molecules with a **C=C** double bond).
- The C=C in each monomer opens up to a single bond, and the monomers join into a long chain.

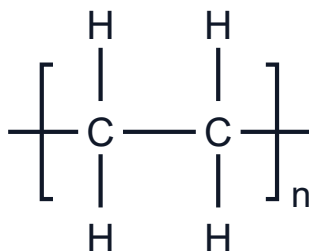


n ethene $\rightarrow$ poly(ethene): each C=C opens up and links to the next monomer.

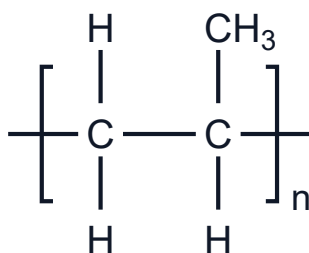
- No other product** forms, so the **repeating unit** has exactly the same atoms as the monomer.
- Examples: ethene makes poly(ethene); propene makes poly(propene).

Drawing the repeating unit

- 1. Draw the two carbon atoms of the C=C, now joined by a single bond.
 - 2. Keep every other atom or group on those carbons exactly as in the monomer.
 - 3. Draw a bond out from each of the two carbons, through a bracket on each side, and write **n** after the brackets.
- Equation: $n \text{ CH}_2=\text{CH}_2 \rightarrow -(\text{CH}_2-\text{CH}_2)_n-$
- Repeating unit of poly(ethene):



- In poly(propene), the CH₃ group is a branch. Only the two carbons of the C=C are in the main chain:



Working backwards

- To find the monomer, take the two chain carbons of the repeating unit, join them with a double bond, and remove the brackets, the **n** and the bonds that stick out.
- In a section of chain, the pattern repeats every two carbon atoms: that two-carbon section is the repeating unit.
- n** is large (often thousands), and the relative formula mass of the polymer = **n** × the relative formula mass of the monomer.

Don't lose marks

- ✗ Leaving the C=C in the repeating unit. It must be a single bond.
- ✗ Forgetting the bonds through the brackets, or the **n**.
- ✗ Putting the CH₃ of propene into the main chain, making a three-carbon backbone.
- ✗ Saying water or another small molecule forms in addition polymerisation. Nothing else forms.
- ✗ Drawing the extending bonds from a side group instead of from the two chain carbons.

More tips

Memory tricks

- Open the door and hold hands: the C=C opens, and each carbon reaches out to link with the next monomer.
- Repeating unit = the monomer with its double bond made single and two 'arms' through the brackets.
- Side groups such as CH₃ or Cl hang off the chain; they never go into the main chain.
- Naming: 'poly' + the monomer's name in brackets.

Exam technique

- Draw the brackets tall enough that the extending bonds clearly pass through them.
- Check that your repeating unit has the same number of each type of atom as the monomer.
- Use the words 'monomer', 'polymer', 'repeating unit' and 'double bond' in explanations.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Define monomer and polymer

Monomers are small molecules that join together in large numbers to make a very large molecule, a polymer.

Grade 4

Name the polymer made from an alkene

Write 'poly' and put the monomer's name in brackets: propene gives poly(propene).

Grade 5

Recognise monomers that form addition polymers

The monomer must contain a C=C double bond.

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