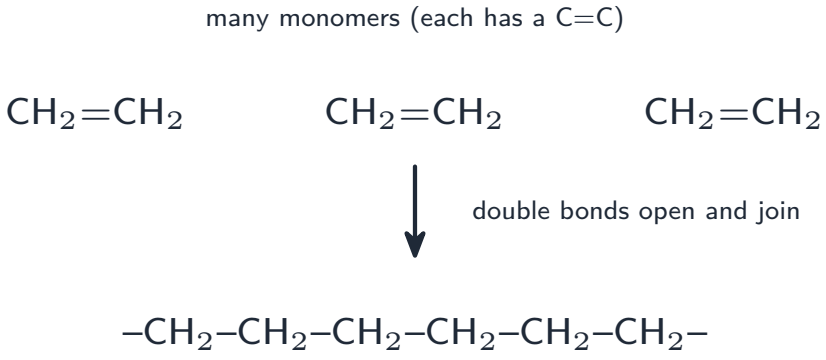
Polymerisation

A-Level Chemistry

Addition polymerisation

In **addition polymerisation** 加成聚合, many small molecules join into one very long chain, with no other product made.

Each small molecule is a **monomer** 单体. It must be unsaturated —it has a C=C double bond. The double bond opens up so that the monomers can link together. The long chain that forms is the **polymer** 聚合物.



Each monomer's double bond opens, and the monomers join end to end into one long chain —with no other product made

Poly(ethene), a common addition polymer, is supplied as tiny pellets a few millimetres across; these are later melted and moulded into bottles, bags and other products

Repeat units

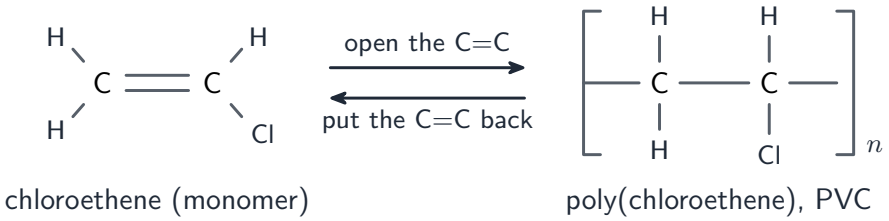
The **repeat unit** 重复单元 is the small part that is copied again and again along the chain. To find it, take the monomer, change the C=C to a single C–C, and draw bonds going out at each end.

- **poly(ethene)** 聚乙烯 is made from ethene:

$$n\,\mathrm{CH_2{=}CH_2} \rightarrow -(\mathrm{CH_2{-}CH_2})_n-$$

- **poly(chloroethene)** 聚氯乙烯 (PVC) is made from chloroethene:

$$n\,\mathrm{CH_2{=}CHCl} \rightarrow -(\mathrm{CH_2{-}CHCl})_n-$$



Finding the repeat unit: change the monomer's C=C to a single bond and draw bonds out at each end; reverse it to find the monomer

Finding the monomer

To go the other way, look at one repeat unit of the polymer, and put the C=C double bond back in. That gives you the monomer.

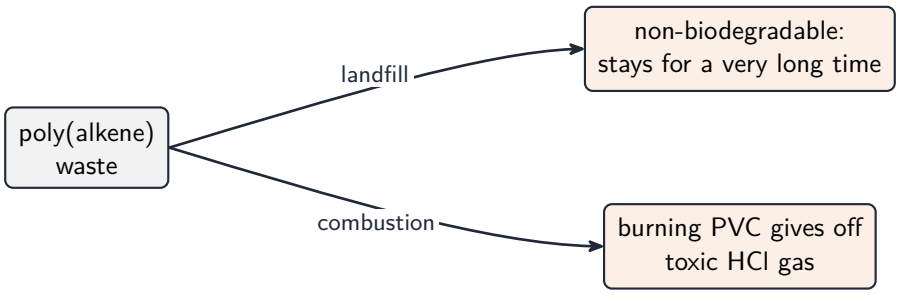
Worked example. A polymer has the repeat unit $-(CH_2-CH(CH_3))_n-$. Identify the monomer and name the polymer. Reverse the rule you used to build it: rub out the bonds sticking out at each end, and turn the single C-C **in the backbone** back into a **C=C**. That gives $CH_2=CH(CH_3)$, which is propene - so the polymer is **poly(propene)**. Two checks catch most errors: the monomer must have the **same molecular formula** as the repeat unit (addition polymerisation adds nothing and loses nothing), and the double bond goes back into the **backbone**, never into the side group.

The problem of disposal

Poly(alkene)s are very hard to get rid of:

- they are **non-biodegradable** 不可生物降解—microbes cannot break them down, so they stay in the ground for a very long time.
- their **combustion** 燃烧 (burning) can release harmful gases. For example, burning PVC gives off toxic hydrogen chloride.

Most addition polymers are non-biodegradable, so they build up as waste in the environment



Poly(alkene) waste is hard to dispose of: it is non-biodegradable, and burning PVC releases toxic hydrogen chloride

Exam tips

- Draw the **repeat unit** in brackets with the two bonds crossing them and n outside; keep the backbone carbons.
- Deduce the **monomer from a polymer** (and vice versa) —a very common question.
- Addition polymers are **inert and non-biodegradable** —link to landfill, recycling and incineration issues.
- Do not confuse with condensation (no small molecule is lost in addition polymerisation).