

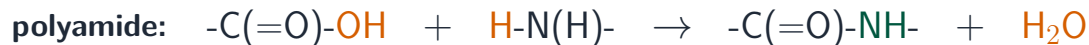
Exercise walk-through

35.1

Condensation polymerisation

A-Level Chemistry

Condensation polymerisation



every new ester or amide link loses a small molecule (condensation)

In **condensation polymerisation**,

monomers join **and** a small molecule is lost.

Each monomer needs **two** reactive groups.

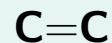
- **polyester** – ester links (diol + diacid)

- **polyamide** – amide links (diamine + diacid)

Addition vs condensation

addition polymerisation

- monomer has a



- the double bond opens and the monomers join

- **nothing else** is lost

e.g. ethene $\rightarrow$
poly(ethene)

condensation polymerisation

- each monomer has **two** functional groups

- a **small molecule** (H_2O or HCl) is lost

- ester or amide links form

e.g. a polyester or
polyamide

- **addition** – a $\text{C}=\text{C}$
opens, **nothing** lost

- **condensation** –
two-group monomers join, a
small molecule **lost**

The two polymerisations, and the monomers each needs

addition polymerisation

monomers with a $C=C$ double bond join with **nothing lost**

condensation polymerisation

poly-

monomers join and a **small molecule** – usually water or HCl – is lost each time

a polyester needs

a **dicarboxylic acid**
each monomer

and a diol – **two** functional groups on

a polyamide needs

a dicarboxylic acid and a diamine

or one monomer

a single aminocarboxylic acid can polymerise with itself – as **amino acids** do, making proteins natural polyamides

finding the monomer

break the chain at the ester or amide link and **add back** the water that was lost

Two functional groups per monomer is what makes a chain possible at all. One group gives a dimer and stops.

Finding the monomers

polyester (ester links)



break each link; add back $-\text{OH}$ and $-\text{H}$



diol



dicarboxylic acid

The **repeat unit**

contains parts of **both** monomers.

To find the **monomers**,
break the chain at each ester or amide link and add back $-\text{OH}$ and $-\text{H}$ to the cut ends.

Degradable polymers



- **poly(alkene)s** are inert (strong non-polar bonds) – hard to **biodegrade**
- polyesters & polyamides **are** biodegradable – their links **hydrolyse**

Exercises 2.1·3.1

2.1 Name the small molecule lost when a diol and a dicarboxylic acid form a polyester.[1]

2.2 Name the type of link in a polyamide. [1]

3.1 A polyamide is made from: [1]

☐

A an alkene only

B a diol and a dicarboxylic acid

C a diamine and a dicarboxylic acid

D a single alcohol

Exercises 2.1-3.1

2.1 Name the small molecule lost when a diol and a dicarboxylic acid form a polyester.[1]

2.1

- water
-

2.2 Name the type of link in a polyamide. [1]

2.2

- an amide link / peptide bond
-

3.1 A polyamide is made from: [1]

☐

A an alkene only

B a diol and a dicarboxylic acid

C a diamine and a dicarboxylic acid

D a single alcohol

3.1 C

- A polyamide forms from a diamine and a dicarboxylic acid (or a dioyl chloride)

Exercise 3.2

3.2 When a section of polyester is hydrolysed, the monomers recovered are: [1]

☐

A two alkenes

B a diol and a dicarboxylic acid

C two diamines

D an amino acid only

Exercise 3.2

3.2 When a section of polyester is hydrolysed, the monomers recovered are: [1]

☐

A two alkenes

B a diol and a dicarboxylic acid

C two diamines

D an amino acid only

3.2 B

- Hydrolysing a polyester recovers the diol and the dicarboxylic acid

Exercise 3.3 (a)

3.3 A polyester has the repeat unit $-\text{O}-\text{CH}_2\text{CH}_2-\text{O}-\text{CO}-\text{C}_6\text{H}_4-\text{CO}-$.

(a) Draw the two monomers.

[2]

Exercise 3.3 (a)

3.3 A polyester has the repeat unit $-\text{O}-\text{CH}_2\text{CH}_2-\text{O}-\text{CO}-\text{C}_6\text{H}_4-\text{CO}-$.

(a) Draw the two monomers.

[2]

(a)

- the diol $\text{HO}-\text{CH}_2\text{CH}_2-\text{OH}$ (ethane-1,2-diol) and the diacid $\text{HOOC}-\text{C}_6\text{H}_4-\text{COOH}$ (benzene 1,4-dicarboxylic acid)

Exercise 3.3 (b)

3.3 A polyester has the repeat unit $-\text{O}-\text{CH}_2\text{CH}_2-\text{O}-\text{CO}-\text{C}_6\text{H}_4-\text{CO}-$.

(b) Name the small molecule lost when they polymerise.

[1]

Exercise 3.3 (b)

3.3 A polyester has the repeat unit $-\text{O}-\text{CH}_2\text{CH}_2-\text{O}-\text{CO}-\text{C}_6\text{H}_4-\text{CO}-$.

(b) Name the small molecule lost when they polymerise.

[1]

(b)

- water

Exercise 3.4

3.4 Explain why each monomer in a condensation polymer must have **two** functional groups. [2]

Exercise 3.4

3.4 Explain why each monomer in a condensation polymer must have **two** functional groups. [2]

3.4

- with two reactive groups, a monomer can bond at **both** ends; so the chain can keep growing in both directions to form a long polymer – with only one group it would stop after one link