

Week 52

A-Level Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

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A-Level Chemistry

Name: _____ Score: _____

1. In condensation polymerisation:
 - ☐ monomers join and a small molecule (e.g. water) is lost each time
 - ☐ a C=C opens and nothing is lost
 - ☐ no bonds form
 - ☐ only one monomer is used
2. A monomer with a C=C double bond, where nothing else is lost, undergoes:
 - ☐ addition polymerisation
 - ☐ condensation polymerisation
 - ☐ no polymerisation
 - ☐ hydrolysis
3. Poly(alkene)s are hard to biodegrade because they have:
 - ☐ only strong, non-polar C–C and C–H bonds
 - ☐ ester links
 - ☐ amide links
 - ☐ ionic bonds
4. A polyester can be made from:
 - ☐ a diol and a dicarboxylic acid
 - ☐ two alkenes
 - ☐ an alkane and a halogen
 - ☐ a single C=C monomer
5. Monomers with two functional groups that lose a small molecule give:
 - ☐ condensation polymerisation (with ester or amide links)
 - ☐ addition polymerisation
 - ☐ free-radical substitution
 - ☐ no polymer
6. Some polymers are made photodegradable so that light can break them down.
 - ☐ True ☐ False

7. Polymers that can be broken down by microbes or hydrolysis are described as _____.

8. Polymers made by joining monomers with loss of a small molecule (e.g. water) form by _____ polymerisation.

9. Addition polymers form from monomers containing C=C double bonds.

☐ True ☐ False

10. Condensation polymers such as polyesters can be hydrolysed and so are more easily degraded than addition polymers.

☐ True ☐ False

A-Level Chemistry

1. **monomers join and a small molecule (e.g. water) is lost each time**

Each new link releases a small molecule; the monomers need two reactive groups.

2. **addition polymerisation**

Addition polymerisation opens the C=C and joins monomers with no other product.

3. **only strong, non-polar C–C and C–H bonds**

With no polar links to attack, microbes cannot easily break poly(alkene)s down.

4. **a diol and a dicarboxylic acid**

A diol (two –OH) and a dicarboxylic acid (two –COOH) form ester links along the chain.

5. **condensation polymerisation (with ester or amide links)**

Two-group monomers join with loss of a small molecule, forming ester/amide links — condensation.

6. **True**

Photodegradable polymers are designed to be broken down by light.

7. **degradable**

They reduce plastic waste.

8. **condensation**

Polyesters and polyamides form this way.

9. **True**

No small molecule is lost.

10. **True**

The ester/amide links can be broken.

35.1 Condensation polymerisation

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS repeat unit 重复单元 • monomer 单体 • polyester 聚酯 • polyamide 聚酰胺 • condensation polymerisation 缩合聚合

Objective

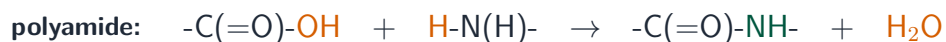
Build the skills to answer exam questions on **condensation polymerisation** 缩合聚合 — making **polyesters** 聚酯 and **polyamides** 聚酰胺, and finding the **monomers** 单体 or **repeat unit** 重复单元.

You must be able to:

- describe condensation polymerisation (two-group monomers, a small molecule lost)
- name the monomers for a polyester or polyamide
- deduce the monomers/repeat unit from a section of polymer

1 Worked examples

■ Links and monomers



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

A polyester forms ester links, a polyamide forms amide links; each new link releases a small molecule (e.g. water)

- **condensation:** each monomer has **two** reactive groups; a small molecule (water or HCl) is lost at each link.
- **polyester** = diol + dicarboxylic acid (or diacyl chloride); **polyamide** = diamine + dicarboxylic acid.

polyester (ester links)



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



diol



dicarboxylic acid

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

2 Practice

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 Exam-style questions

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

3.2 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

3.3 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]

(b) Name the small molecule lost when they polymerise. [1]

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

Solutions

2.1 water.

2.2 an amide link / peptide bond.

3.1 C. A polyamide forms from a diamine and a dicarboxylic acid (or a diol chloride).

3.2 B. Hydrolysing a polyester recovers the diol and the dicarboxylic acid.

3.3 (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).

(b) water.

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.

- 8** Asparagine and aspartic acid are two naturally occurring amino acids. Their structures and isoelectric points are shown in Table 8.1.

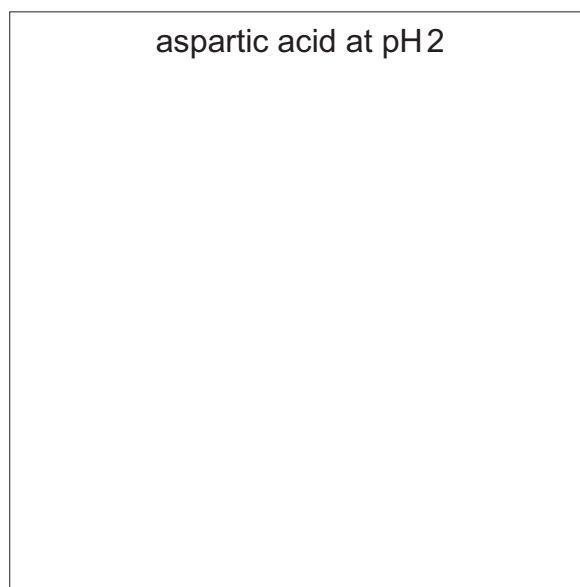
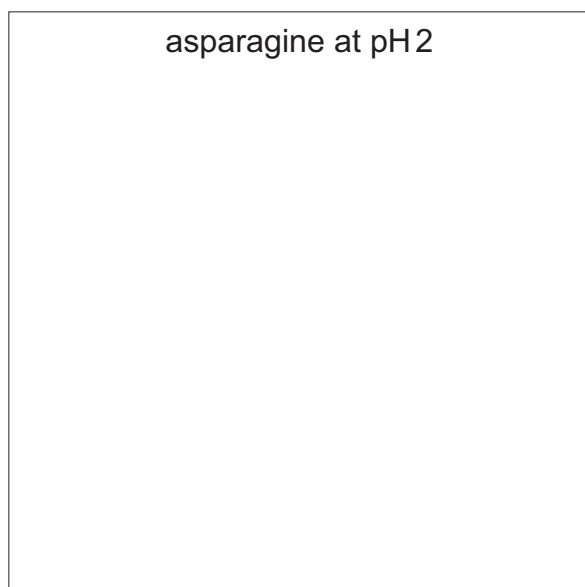
Table 8.1

amino acid	structure	isoelectric point
asparagine	$\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{CONH}_2$	5.41
aspartic acid	$\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{COOH}$	2.77

- (a)** Define isoelectric point.

.....
..... [1]

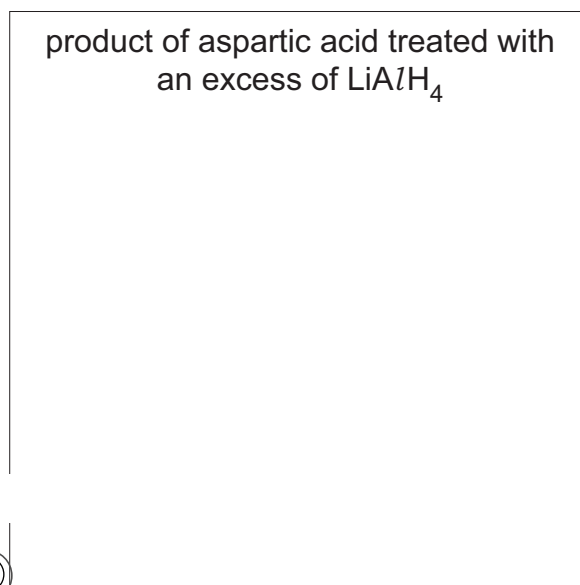
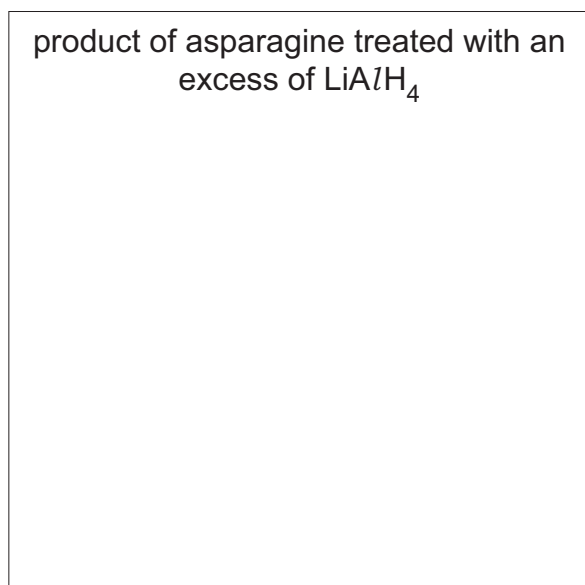
- (b)** Draw the structures of asparagine and aspartic acid at pH 2.



[2]

- (c)** Asparagine and aspartic acid are treated separately with an excess of LiAlH_4 .

Draw the structures of the organic products of these reactions.



- (d) Propanedioic acid, $\text{HOOCCH}_2\text{COOH}$, is treated with an excess of thionyl chloride, SOCl_2 . Propanedioyl chloride, $\text{ClOCCH}_2\text{COCl}$, is formed.

(i) Write an equation for this reaction.

..... [1]

- (ii) Propanedioyl chloride reacts with an excess of asparagine to form compound **G** with molecular formula $\text{C}_{11}\text{H}_{16}\text{N}_4\text{O}_8$.

Each molecule of compound **G** has four amide groups.

Draw the structure of compound **G**.

Compound **G**, $\text{C}_{11}\text{H}_{16}\text{N}_4\text{O}_8$

[2]

- (e) Asparagine is hydrolysed with an excess of hot NaOH(aq) .

Draw the structure of the organic product of this reaction.

[2]

- (f) A polymer can form from asparagine, $\text{HOOCCH}(\text{NH}_2)\text{CH}_2\text{CONH}_2$, as the only monomer.

Draw a length of the polymer chain containing **three** monomer residues.

Clearly label the repeat unit of the polymer on your diagram.

[3]

(g) Aspartic acid exists in two optically active forms.

- (i)** Plane polarised light is passed through pure samples of these two optically active forms in solutions of the same concentration.

Describe **two** similarities and **one** difference in their effect on the plane polarised light.

similarities

.....

difference

.....

[2]

- (ii)** Give the term used to describe a mixture of equal amounts of the two optically active forms.

..... [1]

[Total: 16]

Question 9 starts on page 20.

35.2 Predicting the type of polymerisation

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS addition polymerisation 加成聚合 • condensation polymerisation 缩合聚合 • monomer 单体
 • amino acid 氨基酸 • repeat unit 重复单元

Objective

Build the skills to answer exam questions on **predicting the type of polymerisation**
 判断聚合类型 — telling **addition** 加成聚合 from **condensation** 缩合聚合 from the monomer and the product.

You must be able to:

- use the monomer's structure to predict the polymerisation type
- recognise addition ($C=C$, nothing lost) vs condensation (two groups, small molecule lost)

1 Worked examples

■ Which type?

addition polymerisation

- monomer has a $C=C$
 - 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 opens a $C=C$ and loses nothing; condensation joins two-group monomers and loses a small molecule

polyester (ester links)



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



diol



dicarboxylic acid

Find the monomers to predict the polymerisation type

Clue	Type
monomer has a $\text{C}=\text{C}$, nothing else lost	addition
each monomer has two functional groups; a small molecule is lost; chain has ester/amide links	condensation

2 Practice

2.1 State the type of polymerisation when ethene forms poly(ethene). [1]

2.2 State the type of polymerisation when a small molecule is lost at each link. [1]

3 Exam-style questions

3.1 A monomer with **one** $\text{C}=\text{C}$ and no other functional group will undergo: [1]

- **A** addition polymerisation
- **B** condensation polymerisation
- **C** neither
- **D** hydrolysis

3.2 Which observation shows that a polymer formed by **condensation**? [1]

- **A** the monomer had a $\text{C}=\text{C}$
- **B** no small molecule was lost

- **C** water (or HCl) was released and the chain has ester/amide links
 - **D** the polymer is an alkene
-

3.3 For each monomer, predict the type of polymerisation and justify it: [3]

(a) $\text{CH}_2=\text{CHCl}$ (chloroethene)

(b) $\text{HOCH}_2\text{CH}_2\text{OH} + \text{HOOC}(\text{CH}_2)_4\text{COOH}$

(c) a single amino acid $\text{H}_2\text{NCH}_2\text{COOH}$

3.4 Explain how you could tell, from the **product** alone, whether a polymer was made by addition or condensation. [2]

Solutions

2.1 addition polymerisation.

2.2 condensation polymerisation.

3.1 A. One $C=C$ and nothing lost $\rightarrow$ addition polymerisation.

3.2 C. Releasing a small molecule and having ester/amide links shows condensation.

3.3 (a) addition — it has a $C=C$ and nothing is lost.

(b) condensation — two two-group monomers join, losing water $\rightarrow$ polyester.

(c) condensation — the amino acid has two groups ($-NH_2$ and $-COOH$), losing water $\rightarrow$ polyamide.

3.4 an addition polymer has a saturated $C-C$ backbone with no links (the repeat unit is just the monomer); a condensation polymer has ester or amide links along the chain, which can be hydrolysed back to two monomers.

35.3 Degradable polymers

Name: _____ Class: _____ Date: _____

Total: 8 marks

KEY WORDS hydrolysis 水解 • biodegradable 可生物降解 • poly(alkene) 聚烯烃 • degradable polymers 可降解聚合物
• polyester 聚酯

Objective

Build the skills to answer exam questions on **degradable polymers** 可降解聚合物 — why poly(alkene)s last so long, and why polyesters and polyamides can be broken down.

You must be able to:

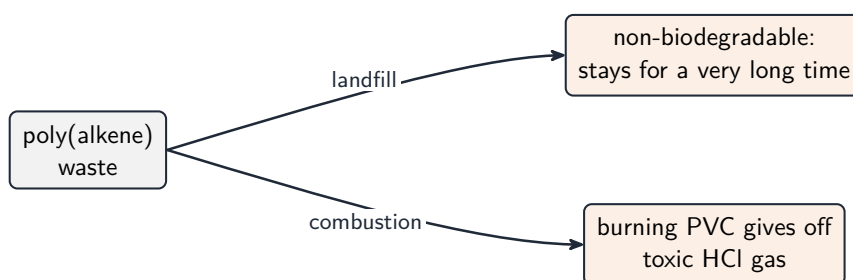
- explain why poly(alkene)s are hard to biodegrade
- explain why polyesters and polyamides are biodegradable
- describe how hydrolysis breaks the links

1 Worked examples

■ Why some polymers degrade and others do not



PET bottles are a polyester — a condensation polymer whose ester links can be hydrolysed, so it can be broken down and recycled



Degradable polymers break down on disposal

- **poly(alkene)s** (e.g. poly(ethene)): only strong, non-polar C–C and C–H bonds → chemically inert → hard to **biodegrade**, last a long time.
- **polyesters** / **polyamides**: have **ester** or **amide** links → these can be broken by acidic or alkaline **hydrolysis** → biodegradable.
- some polymers are made **photodegradable** (light breaks them down).

2 Practice

2.1 State why poly(ethene) is hard to biodegrade. [1]

2.2 Name the reaction that breaks the links in a polyester. [1]

3 Exam-style questions

3.1 Poly(alkene)s are hard to biodegrade because they contain only: [1]

- **A** polar ester links
- **B** amide links
- **C** strong, non-polar C–C and C–H bonds
- **D** C=C double bonds

3.2 A polyester can be broken down by: [1]

- **A** addition
- **B** hydrolysis of the ester links
- **C** combustion only
- **D** none of these

3.3 Explain why a polyamide is biodegradable but poly(propene) is not. [3]

3.4 Suggest **one** environmental advantage of replacing a poly(alkene) packaging with a polyester. [1]

Solutions

2.1 it has only strong, non-polar C–C and C–H bonds, which are chemically inert.

2.2 hydrolysis.

3.1 C. Only strong, non-polar C–C and C–H bonds — chemically inert.

3.2 B. The ester links can be hydrolysed.

3.3 a polyamide has amide links that can be broken by acidic or alkaline hydrolysis; poly(propene) has only inert C–C and C–H bonds with no hydrolysable links; so the polyamide is biodegradable while poly(propene) is not.

3.4 the polyester can be hydrolysed/biodegraded, so it does not persist in the environment as waste.