A-LEVEL CHEMISTRY • EXERCISE SHEET

35.1 Condensation polymerisation

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS monomer 单体 • repeat unit 重复单元 • 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

polyester: -C(=O)-OH + H-O- → -C(=O)-O- + H_2O

polyamide: -C(=O)-OH + H-N(H)- → -C(=O)-NH- + H_2O

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 dioyl chloride); **polyamide** = diamine + dicarboxylic acid.

polyester (ester links)

$\cdots$–CO–O–R–O–CO–R′–CO–O–$\cdots$

↓ break each link; add back –OH and –H

HO–R–OH + HOOC–R′–COOH

diol dicarboxylic acid

To find the monomers, break the chain at each link and add back –OH and –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 $-O–CH_2CH_2–O–CO–C_6H_4–CO-$.

(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 dioyl chloride).

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

3.3 (a) the diol $HO–CH_2CH_2–OH$ (ethane-1,2-diol) and the diacid $HOOC–C_6H_4–COOH$ (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.