Exercise walk-through

Condensation polymerisation ▪ 35.1

eXercise

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

Method — Links and monomers

- **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.

Method — 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)

Method — Links and monomers

polyester (ester links)

$$\cdots\text{–CO–O–R–O–CO–R}'\text{–CO–O–}\cdots$$

break each link; add back –OH and –H

$$\text{HO–R–OH} \quad + \quad \text{HOOC–R}'\text{–COOH}$$

diol

dicarboxylic acid

Practice 2.1 ▪ 1 mark

Name the small molecule lost when a diol and a dicarboxylic acid form a polyester.

Solution 2.1

Method: Links and monomers

Worked steps

water B1.

Practice 2.2 ▪ 1 mark

Name the type of link in a polyamide.

Solution 2.2

Method: Links and monomers

Worked steps

an amide link / peptide bond B1.

Exam-style 3.1 ▪ 1 mark

A polyamide is made from:

A an alkene only

B a diol and a dicarboxylic acid

C a diamine and a dicarboxylic acid

D a single alcohol

Solution 3.1

A an alkene only

B a diol and a dicarboxylic acid

C a diamine and a dicarboxylic acid ✓

D a single alcohol

Worked steps

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

Exam-style 3.2 ▪ 1 mark

When a section of polyester is hydrolysed, the monomers recovered are:

A two alkenes

B a diol and a dicarboxylic acid

C two diamines

D an amino acid only

Solution 3.2

Method: Links and monomers

A two alkenes

B a diol and a dicarboxylic acid ✓

C two diamines

D an amino acid only

Worked steps

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

Exam-style 3.3 ▪ 2 marks

A polyester has the repeat unit $-$O–CH_2CH_2–O–CO–C_6H_4–CO$-$.
(a) Draw the two monomers.
(b) Name the small molecule lost when they polymerise.

Solution 3.3

Method: Links and monomers

Worked steps

(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) M1 *each*.
(b) water B1.

Exam-style 3.4 ▪ 2 marks

Explain why each monomer in a condensation polymer must have **two** functional groups.

Solution 3.4

Method: Links and monomers

Worked steps

with two reactive groups, a monomer can bond at **both** ends M1; so the chain can keep growing in both directions to form a long polymer — with only one group it would stop after one link A1.