

7.3 Polymers

Name: _____ Class: _____ Date: _____

Total: 27 marks

KEY WORDS addition polymerisation

• condensation polymerisation

• monomer

Objective

Draw addition polymers and (HT) explain condensation polymerisation and natural polymers. Original questions for spec statements 4.7.3.1–4.7.3.4.

1 Key knowledge and worked examples

Addition polymerisation – alkene **monomers** join into a **polymer**; the **repeating unit keeps the monomer's atoms exactly** – no other product:

ethene ($\text{C}=\text{C}$) $\rightarrow$ poly(ethene) $-\text{C}-\text{C}-\text{C}-\text{C}-$; propene $\rightarrow$ poly(propene).

(HT) Condensation polymerisation – each monomer has **two functional groups**; joining expels a small molecule, usually **water**:

- ethanediol (two $-\text{OH}$) + hexanedioic acid (two $-\text{COOH}$) $\rightarrow$ **polyester**;
- **amino acids** ($-\text{NH}_2$ + $-\text{COOH}$) $\rightarrow$ **polypeptides**; mixed chains $\rightarrow$ **proteins** (glycine $\text{H}_2\text{NCH}_2\text{COOH}$).

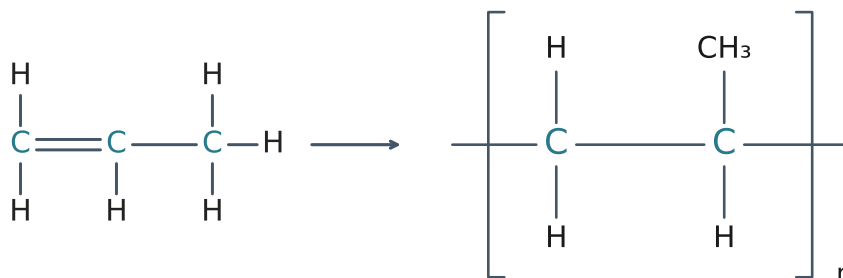
Natural polymers – **DNA**: two chains of four **nucleotides**, **double helix**; **proteins** from amino acids; **starch** and **cellulose** from glucose.

Worked example (2 marks). Why does addition polymerisation form no small by-product?

The double bond simply opens; every monomer atom is incorporated into the chain's repeating unit, so nothing is left over.

Propene monomer

Repeat: methyl side group retained



C_3H_6 per repeat · all atoms retained · no small by-product

HT worked link count. Two diols and two diacids join into one open chain: four molecules need three joining links, releasing three waters. Each molecule can join at both ends because it has two functional groups. A ring would need a different link count.

2 Practice

2.1 What functional group must a monomer have for addition polymerisation? [1]

2.2 Name the polymer formed from propene. [1]

2.3 (*HT*) Name the small molecule lost in condensation polymerisation. [1]

3 Exam-style questions

3.1 Draw the repeating unit of poly(butene), given butene $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$. [3]

3.2 (*HT*) Explain how a polyester forms from a diol and a dioic acid, naming the linkage formed. [4]

3.3 Describe DNA's structure and name the monomers of proteins, starch and cellulose. [4]

3.4 A supplied addition polymer has repeating interior $-\text{CH}_2-\text{CHCl}-$. Draw its fully displayed alkene monomer. Explain whether water is released in this polymerisation. [4]

3.5 (*HT*) Five diol and five diacid molecules join into one finite open chain without branches or rings. Count its joining links and water molecules. Explain why both monomers need two functional groups. [4]

3.6 (*HT*) Glycine has formula $\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$. Identify its two different functional groups. Five glycine molecules form one open polypeptide chain, losing one water per link. Given relative masses 75 for glycine and 18 for water, calculate the chain's relative mass. [5]
