4.3 Synthetic polymers

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

Objective

Build the skills to answer exam questions on **synthetic polymers** : addition polymerisation, drawing repeat units and monomers, condensation polymers (polyesters), and the problems of disposing of polymers.

You must be able to:

- draw the repeat unit of an addition polymer from its monomer
- work out the monomer from a repeat unit
- compare addition and condensation polymerisation
- evaluate ways of disposing of polymers

1 Key knowledge and worked examples

Polymers

idea	rule
addition polymerisation	many monomers with a C=C bond join; the double bond opens; nothing else is made
repeat unit	the monomer with the C=C changed to C−C, two bonds sticking out, brackets and n
naming	poly(monomer): ethene → poly(ethene); propene → poly(propene)
condensation polymerisation	two different monomers join; a small molecule (water) is made at each link
polyesters	a diol (two −OH) + a dicarboxylic acid (two −COOH)

Worked example 1: repeat unit. Draw the repeat unit of poly(propene) from propene, $CH_2{=}CHCH_3$.

1. Known: the C=C is between the first two carbons.
2. Rule: open the double bond; the CH_3 hangs off the chain.
3. Numbers: $-CH_2-CH(CH_3)-$.

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4. Result: $[-\mathbf{CH_2} - \mathbf{CH}(\mathbf{CH_3})-]_n$.

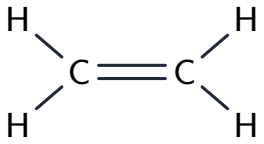
Worked example 2: monomer. A repeat unit is $[-CF_2 - CF_2-]_n$. Find the monomer.

1. Known: two carbons, each with two F.
2. Rule: put the C=C back and remove the brackets.
3. Numbers: $CF_2{=}CF_2$.
4. Result: **tetrafluoroethene**.

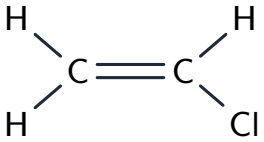
Answer shapes: in an evaluation, give a point for and against each option, then a conclusion.

2 Practice

2.1 Name the polymer made from ethene, and give **one** use. [2]



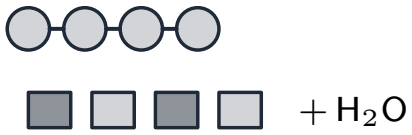
2.2 Draw the repeat unit of the polymer made from chloroethene. [2]



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3 Exam-style questions

3.1 Explain **two** differences between addition and condensation polymerisation. [3]



3.2 Drinks bottles are made from PET, a polyester. Ways to dispose of used bottles are shown in the table.

method	what happens
landfill	bottles are buried in the ground
burning	bottles are burned; heat can make electricity
recycling	bottles are melted and made into new products

(a) Name the **two** types of monomer used to make a polyester, and the small molecule given off. [2]

(b) Explain why PET bottles last a long time in landfill, and give **one** problem caused by burning them. [3]

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(c) Evaluate landfill, burning and recycling as ways to dispose of used PET bottles. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- poly(ethene)
- plastic bags, bottles or cling film

2.2

- two carbons joined by a single bond, with H, H and H, Cl, and bonds sticking out at each end
- brackets and n

3.1

- addition uses monomers with a C=C bond; condensation uses monomers with two functional groups (e.g. −OH and −COOH)
- addition makes only the polymer; condensation also makes a small molecule, water
- addition usually uses one kind of monomer; condensation polyesters use two different monomers

3.2

(a) a diol and a dicarboxylic acid; water

(b) PET is not biodegradable; microorganisms cannot break down its strong bonds, so it stays for hundreds of years; burning releases carbon dioxide (a greenhouse gas) or toxic gases

(c) points to include:

- landfill is cheap and easy, but uses up land and the bottles do not break down (K)
- burning reduces the volume and the heat can make electricity (An)
- but burning releases carbon dioxide and possibly toxic gases (K)
- recycling saves crude oil and energy and reduces waste (An)
- but bottles must be collected and sorted, which costs money (An)
- conclusion: recycling is best where collection is possible; burning with energy recovery is better than landfill (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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