Polymers Unit 1 VCE

1. Consider the small section of a polymer shown in fig. 1.

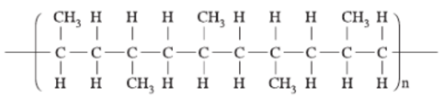


Figure 1 – small section of a polymer chain

a. Give the IUPAC name of the monomer that produced the polymer.\

propene

b. What general class of chemical reaction produced the polymer.
Addition polymerisation

2. Consider the small section of a polymer shown in fig. 2.

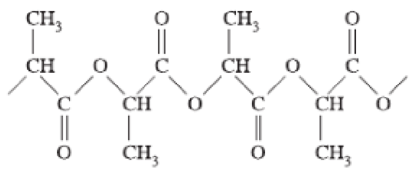


Figure 2 – a small section of a polymer chain

a. Give the IUPAC name of the monomer that formed this polymer.
2-hydroxypropanoic acid

b. What general class of chemical reaction produced the polymer?

condensation polymerisation

c. How does this reaction differ from the one given as the answer to question 1 b. above?

Condensation polymerisation is a reaction between two different functional groups that join together to form a covalent bond, with the simultaneous expulsion of a small molecule such as water, ammonia, or hydrogen chloride.
In addition polymerisation is a reaction where alkene molecules (containing C=C double bonds) link together by breaking the double bonds and forming single C–C bonds between monomers. No small molecules are expelled during this process

3. Consider the small section of a polymer shown in fig. 3.

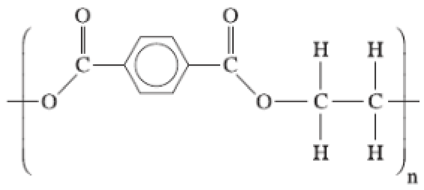
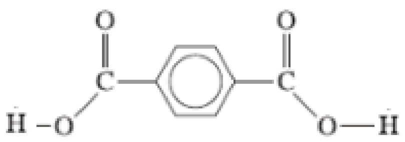


Figure 3 – The repeating unit of a polymer chain

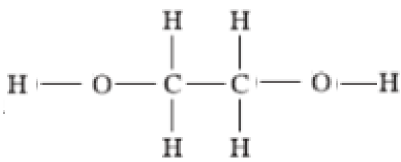
a. This polymer starts to soften at temperatures around 260 °C , whilst the polymer shown in fig. 1 above softens at much lower temperatures.
Give an explanation as to why?
The polymer in fig. 3 has intermolecular forces of attraction comprising of dipole-dipole interactions and significant dispersion forces than the polymer in fig. 1. The stronger intermolecular forces of attraction require a greater amount of energy, hence, greater temperature to break.
The polymer in fig. 1 has intermolecular forces of attraction composed solely of dispersion forces. These dispersion forces are relatively weaker than the polymer in fig. 3 since its molecular mass is much lower than that of the polymer in fig. 3.

b. This polymer is known as a copolymer as it is made of two monomers. Draw the structural formulas of each monomer in the space provided below.

Monomer 1



Monomer 2



4. Consider the small section of a polymer identical to the one shown in fig. 2 above.

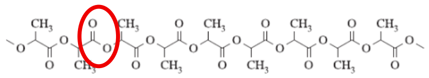
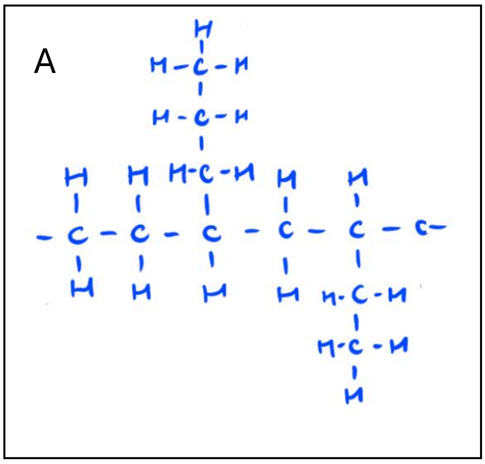


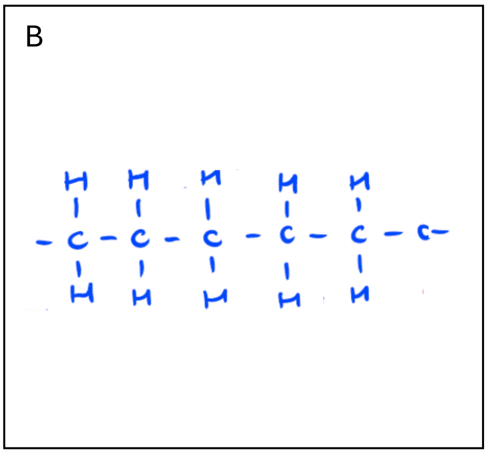
Figure 4 – a small section of polymer formed from one monomer

a. Circle and give the name of the functional group that exists in the polymer.
ester

b. What functional groups reacted to form the link between each monomer?
Carboxyl (-COOH) and hydroxyl(-OH) functional groups.

5. Consider the two polymer structures of polyethene shown below.





a. Which structure represents a thermoplastic that softens at a very low temperatures? Justify your answer.
Structure A
Structure A shows branching. Branching reduces the ability of polymer chains to pack closely in the solid state. As a result, the weak dispersion forces between the polymer chains act over greater distances, weakening their overall attraction. Because the force of attraction is weaker, less energy (lower temperature) is needed to overcome these forces and cause the plastic to soften.

b. Which structure represents a plastic that is most likely used in buoyancy vests? Justify your answer.
Structure A has more space between polymer chains in the solid state because of its branching. This increased spacing reduces the close packing of chains, weakening the intermolecular force, dispersion forces, that hold them together.

a. Under what conditions was polymer A formed?

   High temperature (around 300 ^{o}C) and pressures (1000-3000 atm) plus a catalyst.

b. Under what conditions was polymer B formed?

   Low temperature (60 – 100 ^{o}C) and pressures (2-3 atm)

6. Consider the impact of mixing a high concentration of radical activator in with the ethene monomers in the preparation of polyethene. Discuss the impact on:

   i. Chain length

   High levels of radical activators increase the number of free radicals, initiating more polymer chains but causing premature chain termination, resulting in shorter chain length.

   ii. Mechanical strength

   Shorter chain lengths reduce the tensile strength of plastics. This is because shorter polymer chains experience weaker dispersion forces between them, allowing them to slide past each other more easily. Additionally, shorter chains are less likely to become entangled, which decreases resistance to flow and prevents the formation of a strong, high tensile strength material.

   iii. Melting point

   The melting point of plastics behaves similarly to mechanical strength in relation to chain length. Shorter polymer chains experience weaker dispersion forces, meaning less energy is required to overcome these intermolecular attractions. As a result, plastics with shorter chains have a lower melting point. Additionally, shorter chains are less entangled, which reduces resistance to flow and causes the material to melt at lower temperatures.