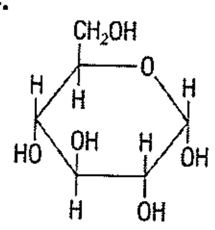
Section 2.1: Introducing Polymers

Section 2.1 Questions, page 83

1. (a) DNA is a natural polymer produced in the nuclei of cells.
(b) Polyethene is a synthetic polymer because it is produced from ethene, a monomer derived from petroleum.
(c) Celluloid is a synthetic polymer because it is made from cellulose, a naturally-occurring polymer, and the synthetic chemicals nitric acid and sulfuric acid.
(d) Cellulose is a natural polymer because it is found in plant cells.
(e) Protein is a natural polymer because it is made in plant and animal cells.
(f) Rubber is a natural polymer because it is made from the sap of rubber trees.
(g) Kevlar is a synthetic polymer because it is made from synthetic chemicals.
(h) Bitumen is a natural polymer because it is found naturally in petroleum.
2. (a) Monomers are the building blocks of polymers.
(b) Homopolymers are formed from a single type of monomer. Copolymers are made from 2 or more different monomers.
3. The monomers in Figures 2, 3, and 4 all consist of carbon atoms. Carbon atoms can form 4 single bonds with itself and other atoms, which allows them to form polymers.
4.



glucose

5. Answers may vary. Sample answer:

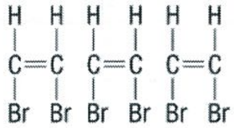
	Natural polymers	**Synthetic polymers**
Similarities	-consist of monomers -formed by addition or condensation reactions	
Differences	-biodegradable -made from renewable resources -come from nature	-many are not be biodegradable -many are made from non-renewable resources -manufactured
Example	rubber	nylon

6. Polymers are useful as paint, auto, and wood finishes because they are lightweight, non-conductive, resistant to heat and moisture, unreactive, and can be coloured.
7. Answers may vary. Sample answer:
During the Second World War, the Axis powers controlled most of the world's natural rubber supply, and so the Allies needed to find alternative sources to feed the great demand for rubber needed for war machines. American scientists came up with a method of making synthetic rubber that doubled the volume of natural rubber produced before the war.

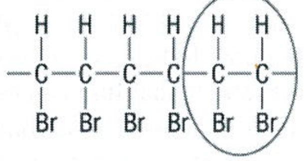
Section 2.2: Synthetic Addition Polymers

Tutorial 1 Practice, page 87

1. (a) Draw three structural diagrams of $C_2H_2Br_2$. Show each molecule with the double-bonded carbon atoms all in a line, and place other atoms below or above that line.

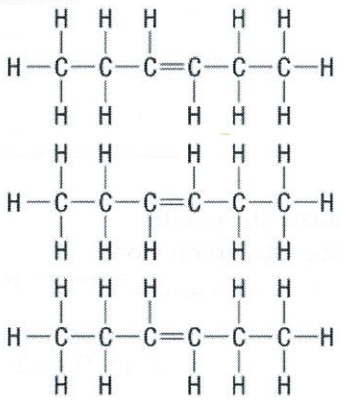


Next, connect the monomers with single bonds to form a chain. Remove the double bonds within the monomer, replacing them with single bonds so that each carbon atom has exactly four bonds. Add lines at each end to indicate that this is just one segment of the longer polymer molecule.

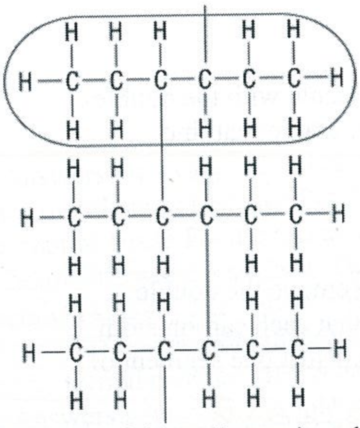


The name of this polymer is polydibromoethene.

(b) Draw three structural diagrams of $CH_3CH_2CH{=}CHCH_2CH_3$. Show each molecule with the double-bonded carbon atoms all in a line, and place other atoms below or above that line.

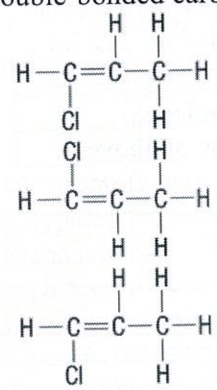


Next, connect the monomers with single bonds to form a chain. Remove the double bonds within the monomer, replacing them with single bonds so that each carbon atom has exactly four bonds. Add lines at each end to indicate that this is just one segment of the longer polymer molecule.

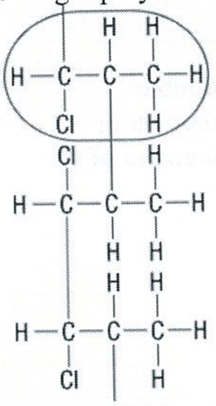


The name of this polymer is polyhex-3-ene.

(c) Draw three structural diagrams of $CHCl{=}CHCH_3$. Show each molecule with the double-bonded carbon atoms all in a line, and place other atoms below or above that line.

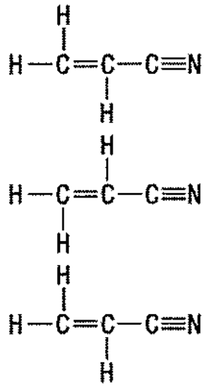


Next, connect the monomers with single bonds to form a chain. Remove the double bonds within the monomer, replacing them with single bonds so that each carbon atom has exactly four bonds. Add lines at each end to indicate that this is just one segment of the longer polymer molecule.

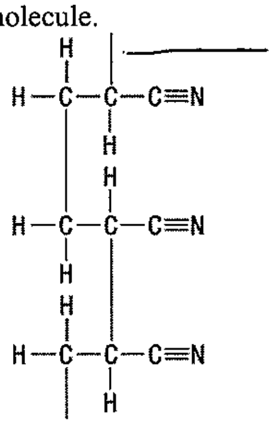


The name of this polymer is poly-1-chloropropene.

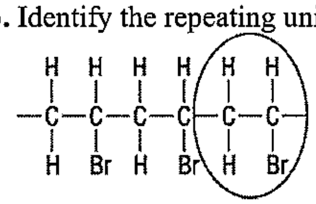
2. Draw three structural diagrams of $CH_2{=}CHCN$. Use Table 1.



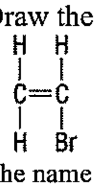
The name of this monomer is cyanoethene. The monomer is more commonly known as acrylonitrile.
Next, connect the monomers with single bonds to form a chain. Remove the double bonds within the monomer, replacing them with single bonds so that each carbon atom has exactly four bonds.
Add lines at each end to indicate that this is just one segment of the longer polymer molecule.



3. Identify the repeating unit.



Draw the monomer. Replace the single bond between two carbons with a double bond.



The name of this monomer is bromoethene.

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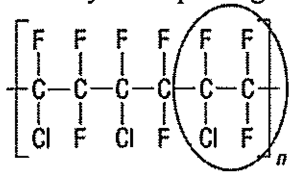
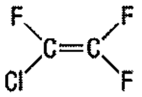
1. Identify the repeating unit.

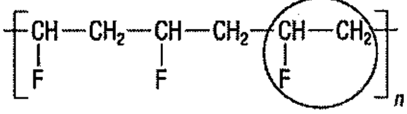


Draw the monomer. Replace the single bond between two carbons with a double bond.

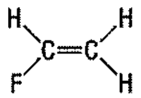


The monomer is chlorotrifluoroethene.

2. (a) Identify the repeating unit.

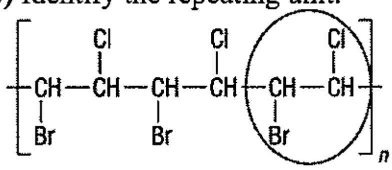


Draw the monomer. Replace the single bond between two carbons with a double bond.

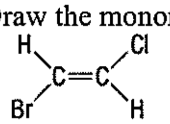


The monomer is fluoroethene, C_2H_3F.

(b) Identify the repeating unit.

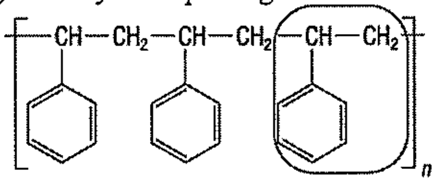


Draw the monomer. Replace the single bond between two carbons with a double bond.

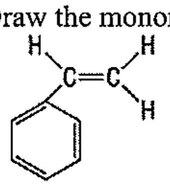


The monomer is trans-1-bromo-2-chloroethene, C_2H_2BrCl.

(c) Identify the repeating unit.

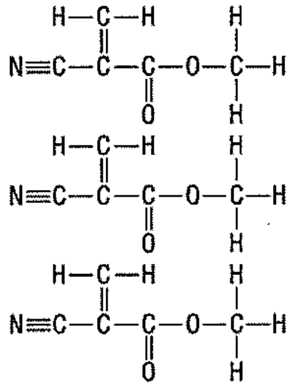


Draw the monomer. Replace the single bond between two carbons with a double bond.

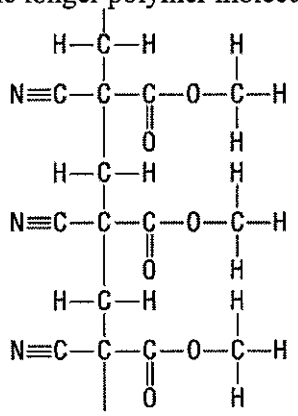


The monomer is phenylethene, $C_6H_5CH{=}CH_2$.

3. Draw three structural diagrams of methyl cyanoacrylate.

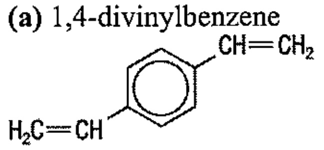


Next, connect the monomers with single bonds to form a chain. Remove the double bonds within the monomer, replacing them with single bonds so that each carbon atom has exactly four bonds. Add lines at each end to indicate that this is just one segment of the longer polymer molecule.



4. Cross-links occur when chemical bonds form between separate polymer strands in two or three dimensions. The more cross-links a polymer has, the more rigid and inflexible it is.

5. (a) 1,4-divinylbenzene



(b) 1,4-divinylbenzene has two double bonds outside the benzene ring, so it can form cross-links with other 1,4-divinylbenzene monomers or with styrene monomers, making the copolymer more rigid.

6. Answers will vary. Answers may include the following information:
Scientists at the University of Southern Mississippi have invented polymers that are self-repairing. They are made of polyurethane, which is scratch resistant. Oxetane and chitosan are added to the polyurethane layer to protect it from scratches. When the polyurethane is scratched, oxetane—which is an unstable ring consisting of an oxygen atom and three carbon atoms—opens up, forming two ends that are reactive. When chitosan is exposed to UV light, it binds with the reactive oxetane ends, thereby filling the scratch.

Section 2.4: Synthetic Condensation Polymers

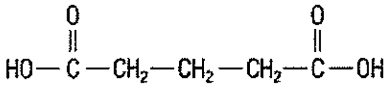
Tutorial 1 Practice, page 98

1. (a) Draw the structure of each monomer.

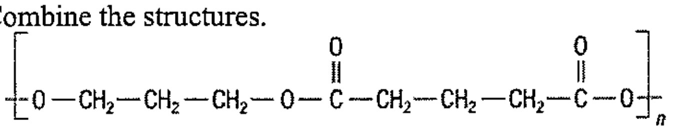
propane-1,3-diol:

$OH–CH_2–CH_2–CH_2–OH$

pentanedioic acid:

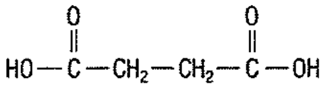


Combine the structures.



(b) Draw the structure of each monomer.

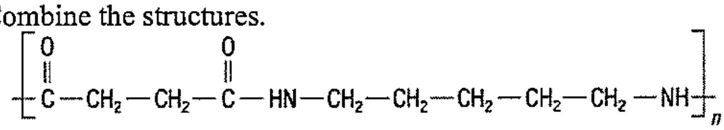
butanedioc acid:



a 5-carbon diamine:

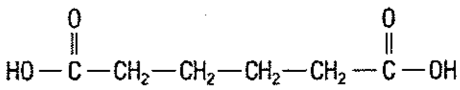
$H_2N–CH_2–CH_2–CH_2–CH_2–CH_2–NH_2$

Combine the structures.



(c) Draw the structure of each monomer.

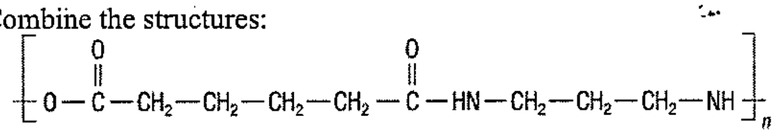
hexanedioic acid:



a 3-carbon diamine:

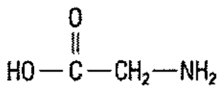
$H_2N–CH_2–CH_2–CH_2–NH_2$

Combine the structures:



Section 2.4 Questions, page 99

1. To draw the monomer that forms the polymer by condensation, identify the repeating unit and add the components of a water molecule to the ends.



2. To draw the monomers that react to form the polymer, identify the repeating units and add the components of a water molecule to the ends of each.

$HOCH_2CH_2OH$