# Large molecules

Download the teacher notes, student workbook and technician notes that accompany this resource at rsc.li/3yPjVIC.

ROYAL SOCIETY OF CHEMISTRY

# Learning objectives

By the end of this session, you will be able to:

- Identify the properties of a monomer.
- State what a polymer is.
- Explain the similarities and differences between polymers.
- Describe the properties and uses of thermosoftening polymers.

Starter activity

# How might chemistry help?

Why is chemistry important in each of these jobs?

Career link

# Patent attorney

Meet Charley, a patent attorney, who uses his chemistry skills and knowledge to understand research into problems to help inventors get legal protection for their inventions, such as new medicines or compounds for carbon capture.


# What do these materials have in common?


Career link

# Senior director of chip research

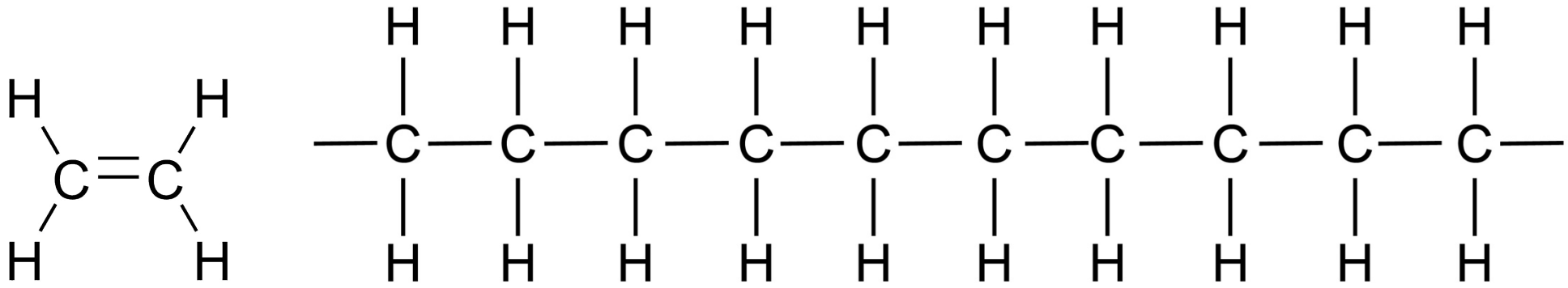
Polymers are all around us, in plastics, glues, fabrics and in our bodies. One example of a polymer is DNA.

Meet Jason, a senior director of chip research, who uses his chemistry skills and knowledge to sequence DNA and identify viruses or new species.


# Monomers and polymers

**Monomers** are small molecules that can be bonded to other molecules and usually contain a carbon–carbon double bond.

When monomers bond together they form very large molecules called **polymers** in the process of polymerisation.



Monomer

Polymer

Activity 1

# Modelling polymerisation

See student workbook

Activity 1

# Modelling polymerisation

- Work in pairs.
- Each of you should put a C atom around your neck and hold a 30 cm ruler in one hand.
- Turn to face your partner so that both rulers are between you.
- Take hold of both rulers.
- You are now modelling the double carbon to carbon bond found in a **monomer**. Each of you are carbon atoms and the two rulers between you represent the double bond holding you both together.
- Form a line of monomers around the outside of the classroom.

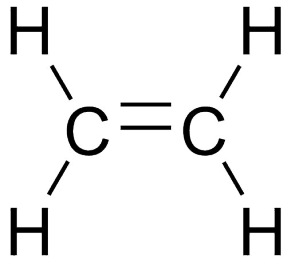
Activity 1

# Modelling polymerisation

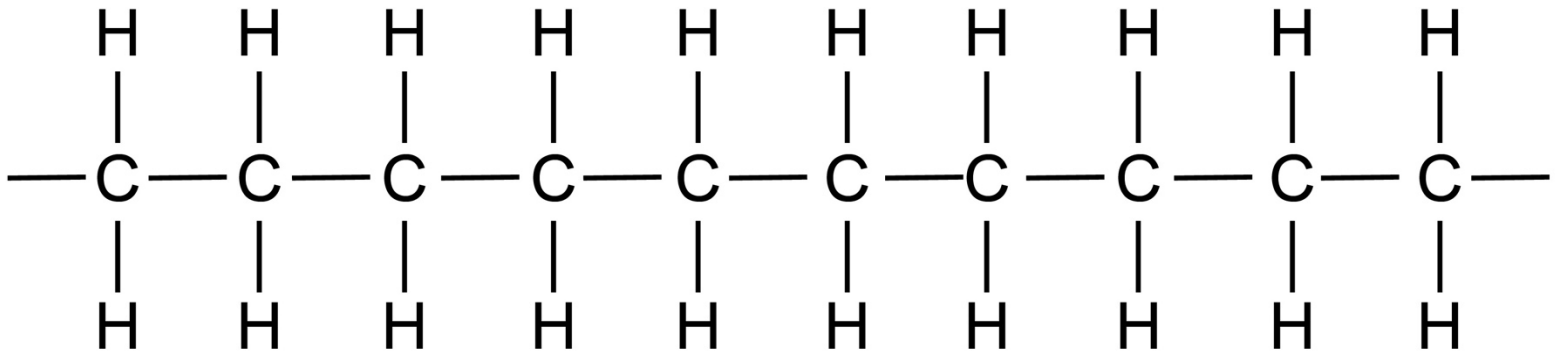
- The first two monomers in the line each break one of their bonds.
- The learners closest to each other from these first two pairs should now also share a ruler.
- This models the double bond breaking and a new bond forming with the neighbouring monomer.
- Continue this process along the line to produce a polymer.

# Polymerisation of ethene

This monomer is called ethene.




During polymerisation the carbon-carbon double bond in the ethene molecule breaks.




Lots of ethene monomers join together to make the polymer poly(ethene).

Activity 2

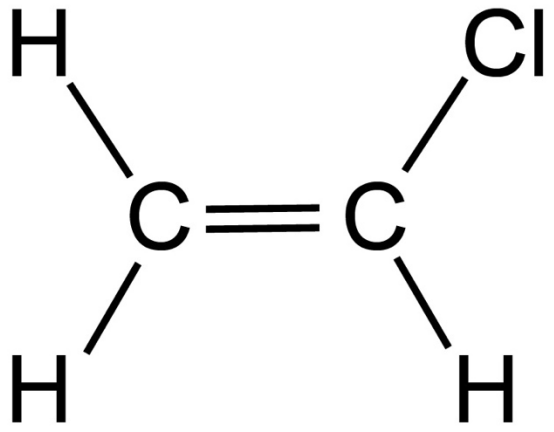
# Polymerisation

See student workbook

Activity 2

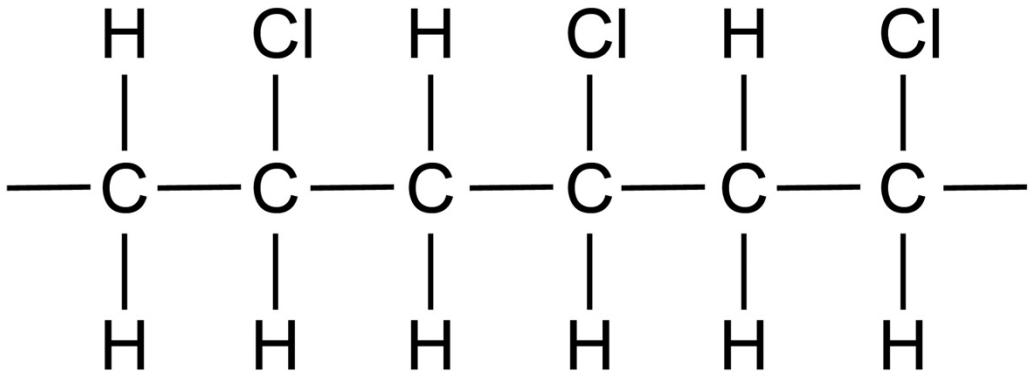
# Polymerisation

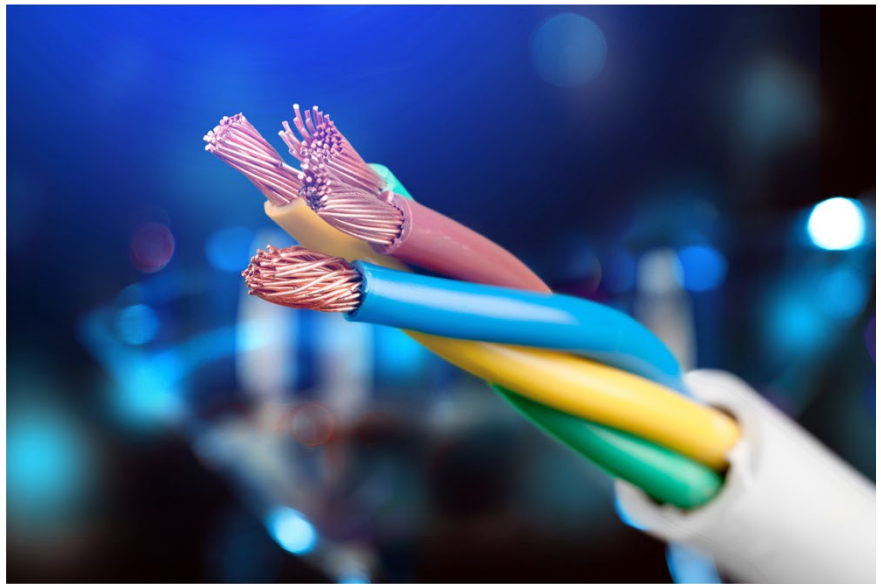
1. This monomer is called chloroethene




Draw a section of the polymer made from three of these monomer molecules.

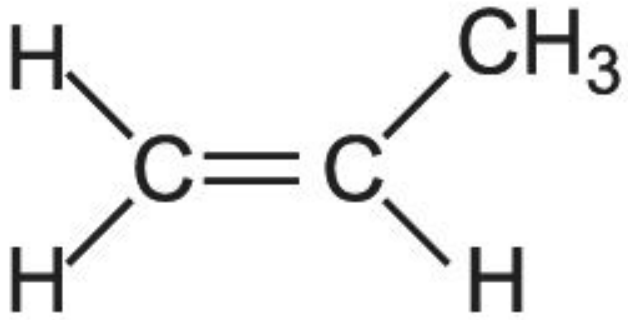
# The polymer made is poly(chloroethene)



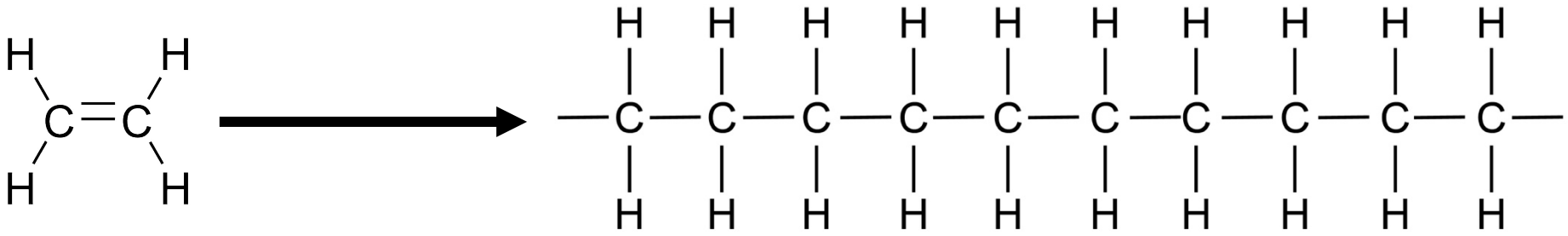
# Polymerisation

2. Draw the polymer formed from four molecules of this monomer.



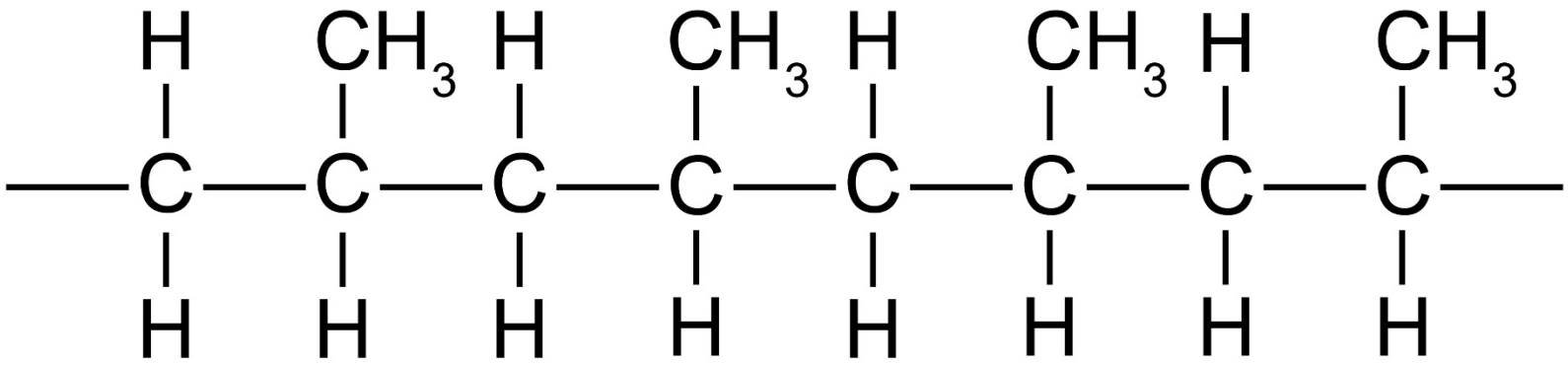

propene

(Hint: think back to ethene and its polymer.)




Activity 2

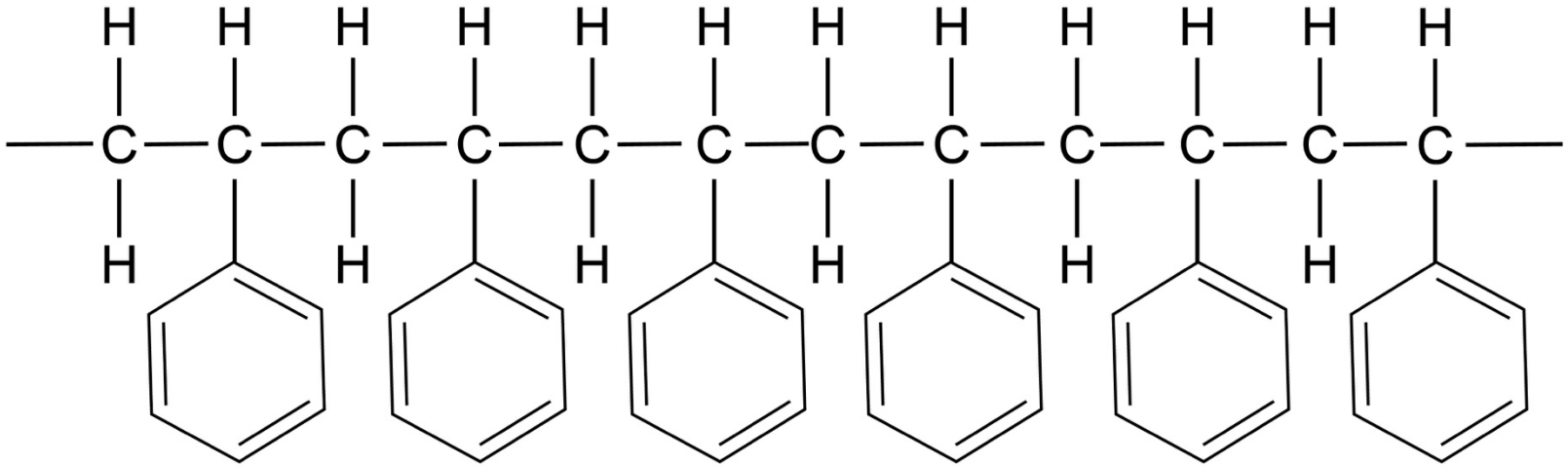
# Poly(propene)



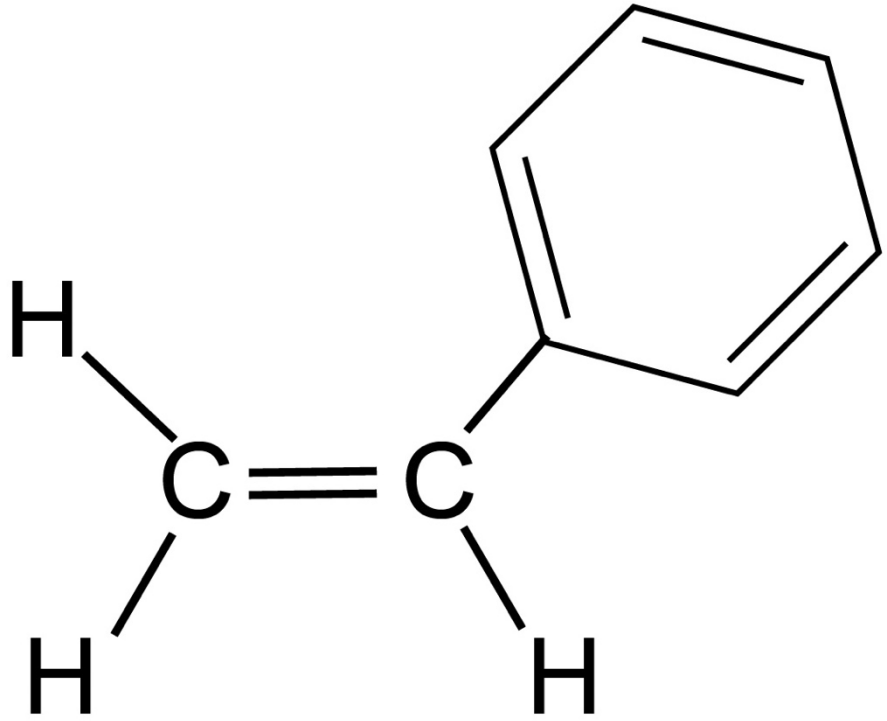
Activity 2

# Polymerisation

3. Draw the monomer used to make this polymer – polystyrene.



# Styrene




Activity 2

# Changing the properties of polymers

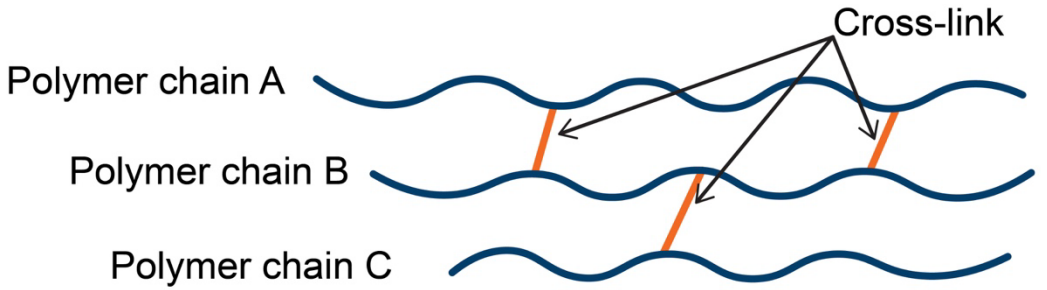
What's the difference between these polymers?

Career link

# Cross-linking in polymers

Cross-links ‘lock’ the polymer chains in place and prevent them from moving over each other.

Meet Margot, a research innovations manager, who develops ways to make plastic break down quickly in the natural environment.





Activity 3

# Thermosoftening polymers

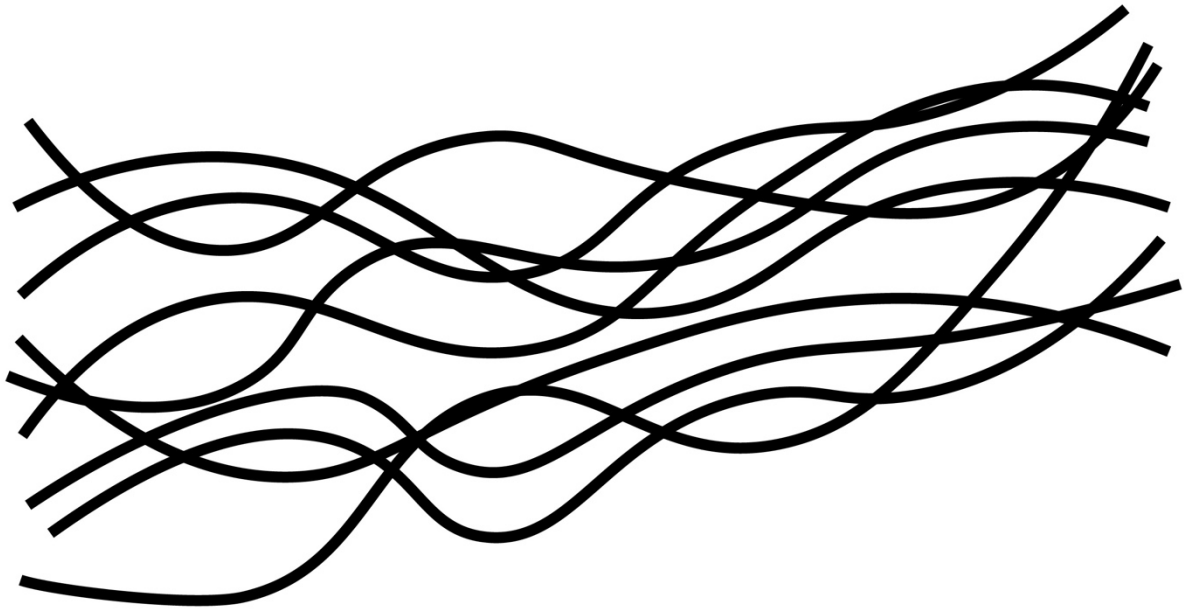
See student workbook

Activity 3

# Thermosoftening polymers

Thermosoftening polymers are a tangle of individual polymer chains.

Why might these types of polymers be useful?



Career link

# Analytical technician in plastics

Meet Celine, an analytical technician in plastics, who uses her chemistry knowledge to develop the structure of plastics so that they will biodegrade in the environment to reduce plastic pollution.


Activity 3

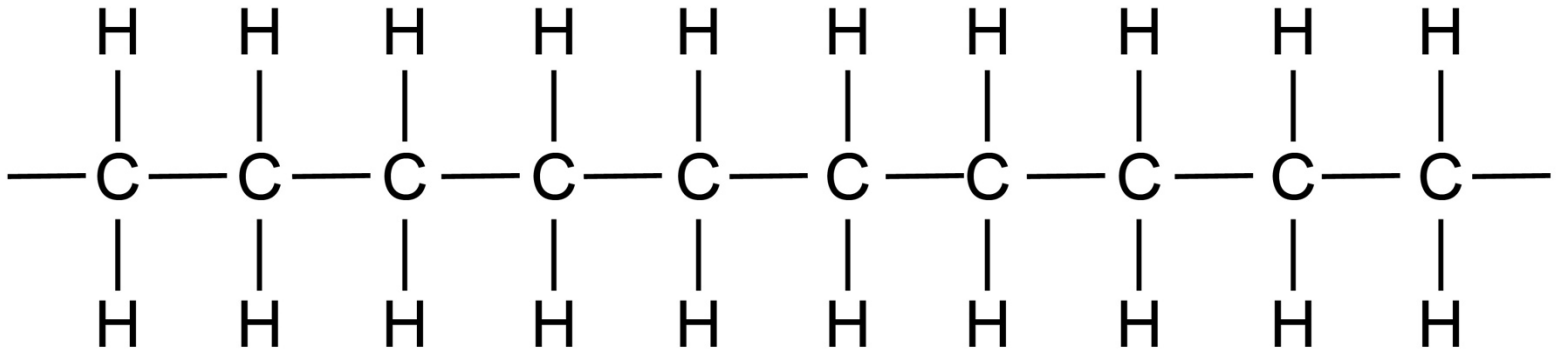
# Thermosoftening polymers

1. Place your sample of polymorph into very hot water. Be careful to avoid burning yourself.
2. When the sample has gone translucent, take care and use a glass rod to retrieve it from the beaker.
3. Remove any excess water after taking the sample out of the water.
4. Mould it into a shape or pen-topper.
5. Leave it to cool.
6. If it becomes difficult to mould, or if you want to create something else, return it to the hot water to soften.

Activity 3

# Polymer review questions

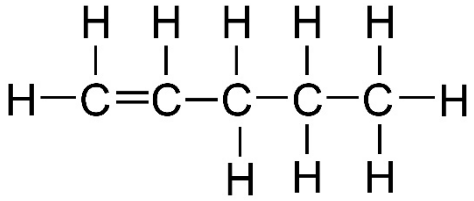
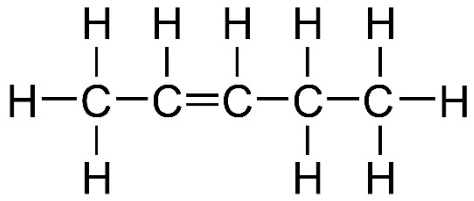
1. Describe the difference between monomers and polymers.
2. Name two examples of polymers.
3. Draw the structure of the monomer pentene.
4. Identify and draw the monomer used to make poly(ethene).

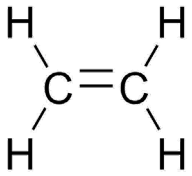


# Polymer review answers

1. A monomer is a molecule that usually contains a carbon-carbon double bond. Polymers are made when monomers bond together to form very large molecules. In the process of addition polymerisation, the carbon-carbon double bonds of the monomers break and the monomers bond together to form a polymer chain.

2. Examples may include poly(ethene), polystyrene, poly(propene), poly(vinyl chloride) or any other sensible example.

3. Either  or 

4. Ethene 

# Acknowledgements

This resource was originally developed by Liverpool John Moores University to support outreach work delivered as part of the Chemistry for All Project.

To find out more about the project, and get more resources to help widen participation, visit our Outreach resources hub: rsc.li/3CJX7M3.