In context

Subject area: Organic chemistry | **Level: 14–16 years (Higher)**

Topic: Addition polymers | **Source: rsc.li/2GRWsij**

1. **Polymers are very useful for making protective armour in some high-impact sports, for example, American football.**

   The shoulder pads are made of a low density poly(ethene) foam inside a case of high density poly(ethene).

   Other polymers like poly(vinyl chloride), poly(propene) and poly(styrene) also have important uses.

Source: Enavto Elements

a) Explain what is meant by a polymer.

Answer: *A very long chain molecule made of many smaller molecules, called monomers.*

b) Explain why polymers are ideal for making high-impact sports equipment.

Answer: *Polymers can be engineered to have particular properties, depending on the particular use.*
They are durable, water resistant, may be easily moulded, and can withstand high-impact shock.

c) Name the substance that polymerises to form poly(ethene).

Answer: *Ethene.*

Poly(ethene), poly(vinyl chloride), poly(propene) and poly(styrene) all belong to a particular class of polymer.

d) What is the name of this polymer class?

Answer: *Addition polymers.*

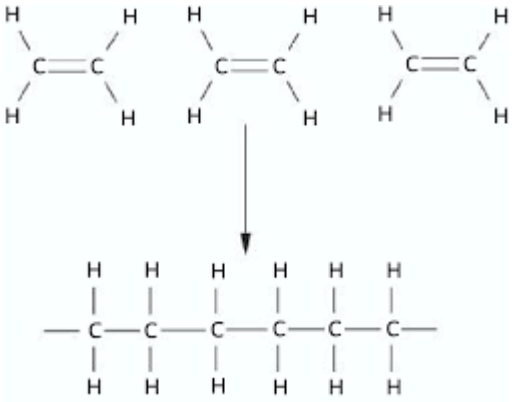
e) What structural feature is common to the monomers that make the polymer type in part c)?

Answer: *All contain a carbon double bond.*

f) Explain the difference in the arrangement of polymer chains in high density and low density poly(ethene).

Answer: *The chains in high density poly(ethene) are packed more closely together than in low density poly(ethene).*

The diagram below shows three ethene monomers forming a section of a poly(ethene) polymer.

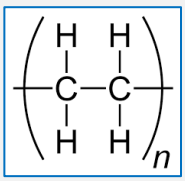


g) Explain how the process takes place.

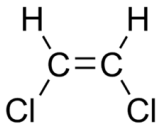
Think about how the bonds in the monomers change in order to form the polymer.

Answer: *Carbon double bonds turn into single bonds.*
Carbon atoms that were forming the double bond form single bonds to other monomers.

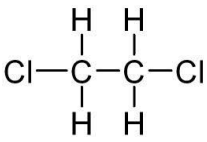
h) Draw the repeat unit for poly(ethene).



These two molecules may look similar, but they can behave very differently.



Molecule 1



Molecule 2

i) One of these molecules is called dichloroethane and the other is called dichloroethene.

Which one is which?
Write your answer into the table below.

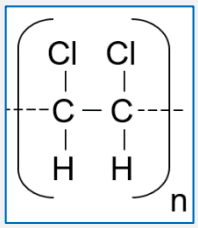
Name of molecule	Molecule 1 or molecule 2
Dichloroethane	***Answer:*** *Molecule 2.*
Dichloroethene	***Answer:*** *Molecule 1.*

j) One of the molecules may polymerise, and the other will not.

State which will polymerise.
Give a reason.

Answer: *Molecule 1.*
It has a carbon double bond.

k) Draw the repeat unit for the polymer that does polymerise.



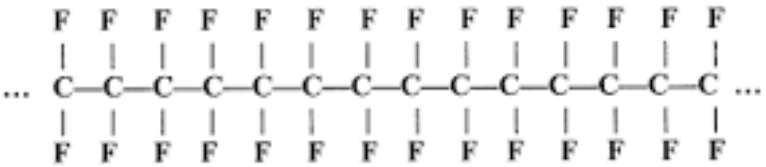
2. Teflon™ is a brand name for the polymer made from a monomer called tetrafluoroethene.

Teflon has some special properties, for example, it is a very slippery polymer on some surfaces.

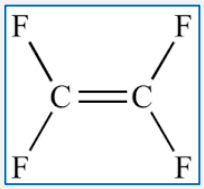
It is used to make ice hockey pucks.

Teflon has the structure shown below.

Source: Enavto Elements



a) Draw the structure of the monomer that would make Teflon.



b) State the empirical (simplest whole number ratio) formula of:

i. The monomer

Answer: *CF_2*

ii. The polymer

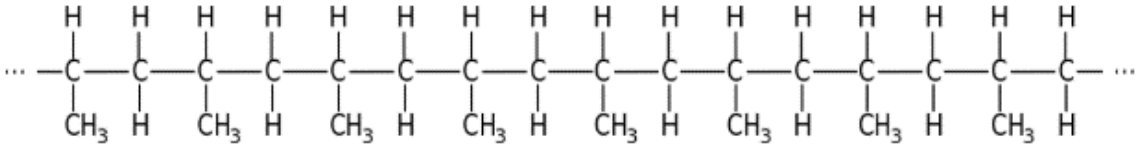
Answer: *CF_2*

c) The average relative molecular mass of a sample of Teflon was found to be 120,000.

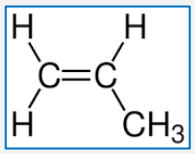
Calculate the average number of monomers in one polymer chain of Teflon.
(RAM data: C = 12, F = 19)

Answer: *1,200 monomer units.*

A polymer that is used to make high-impact protective equipment in ice hockey has the structure below.



d) Draw the structure of the monomer that forms this particular polymer.



e) Name the monomer and polymer.

Answer: *The monomer is propene.*
The polymer is poly(propene).