

6.2.3 Polyesters and Polyamides

There are two **types** of polymerisation: **addition** and **condensation**

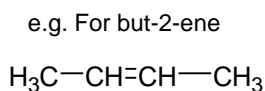
Addition Polymerisation

An **addition polymer** forms when unsaturated monomers react to form a polymer
Monomers contain C=C bonds

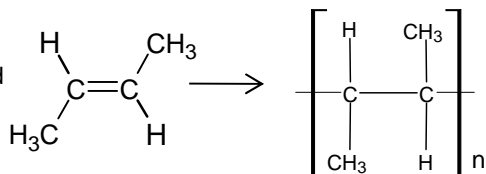
Poly(alkenes) are chemically inert due to the strong C-C and C-H bonds and **non-polar** nature of the bonds and therefore are non-biodegradable.

Chain forms when same basic unit is repeated over and over.

You should be able to draw the polymer repeating unit for any alkene



It is best to first draw out the monomer with groups of atoms arranged around the double bond



Condensation Polymerisation

The two most common **types** of condensation polymers are **polyesters** and **polyamides** which involve the formation of an **ester** linkage or an **amide** linkage.

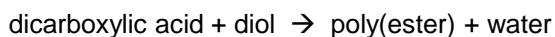
In condensation polymerisation there are two different monomers that add together and a small molecule is usually given off as a side-product e.g. H_2O or HCl .

The monomers usually have the same functional group on both ends of the molecule e.g. di-amine, di carboxylic acid, diol, diacyl chloride.

Forming polyesters and polyamide uses these reactions we met earlier in the course

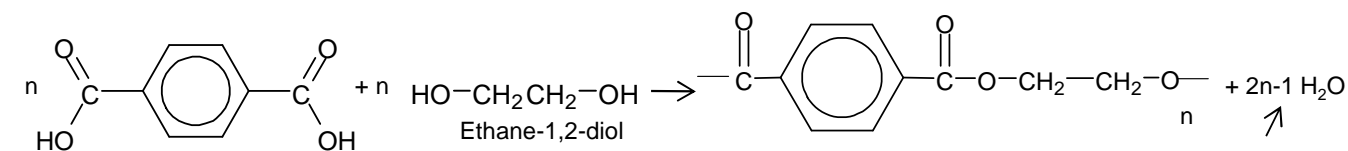


If we have the same functional group on each end of molecule we can make polymers so we have the analogous equations:



Using the carboxylic acid to make the ester or amide would need an acid catalyst and would only give an equilibrium mixture. The more reactive acyl chloride goes to completion and does not need a catalyst but does produce hazardous HCl fumes.

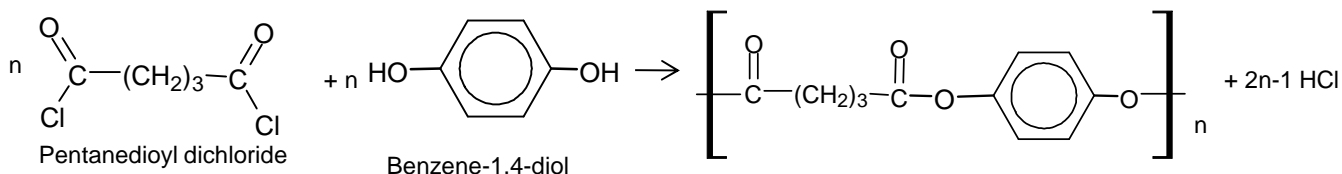
Terylene- a common polyester



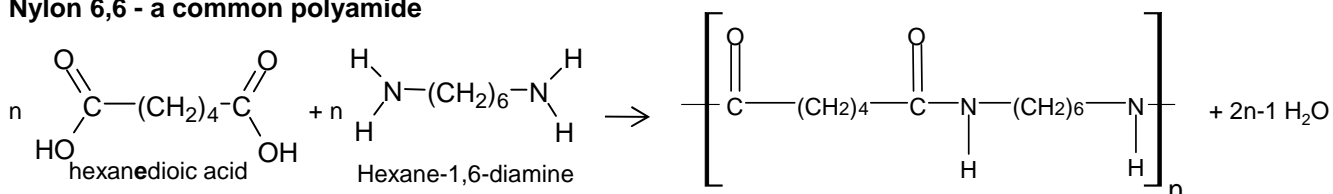
Benzene-1,4-dicarboxylic acid

Terylene fabric is used in clothing, tire cords

The -1 here is because at each end of the chain the H and OH are still present

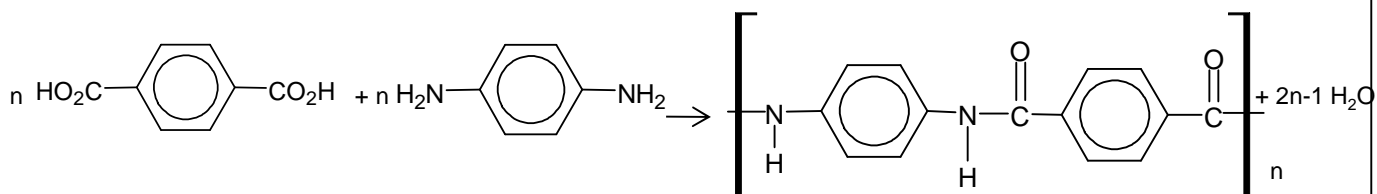


Nylon 6,6 - a common polyamide



The 6,6 stands for 6 carbons in each of the monomers. Different length carbon chains produce different polyamides

Kevlar- a common polyamide

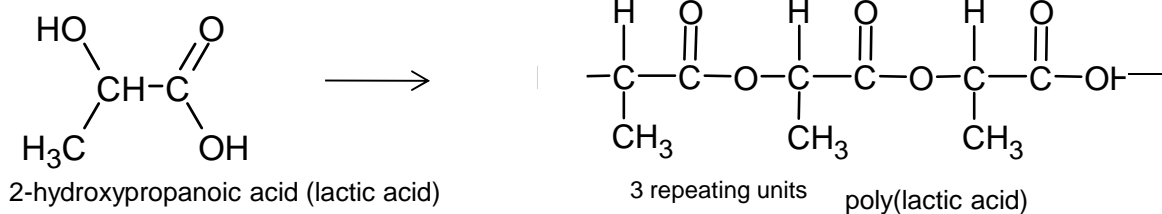
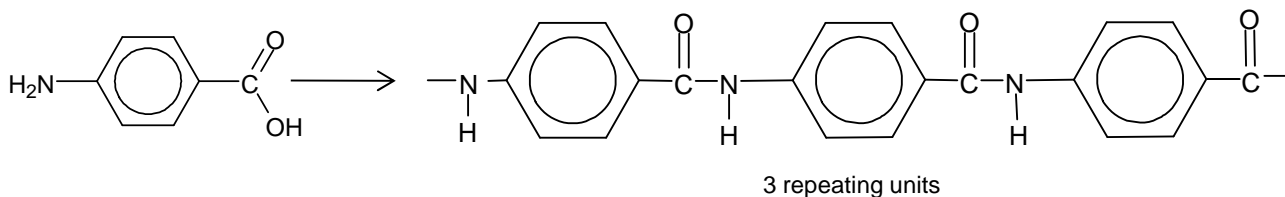
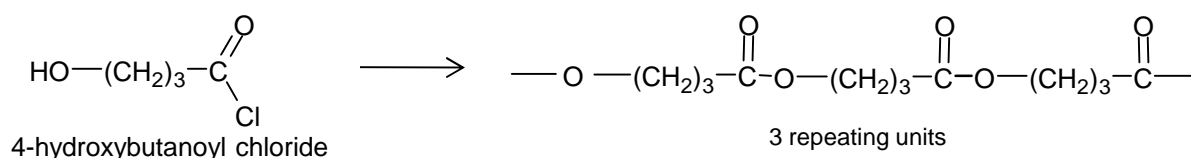


Note on classification for condensation polymers

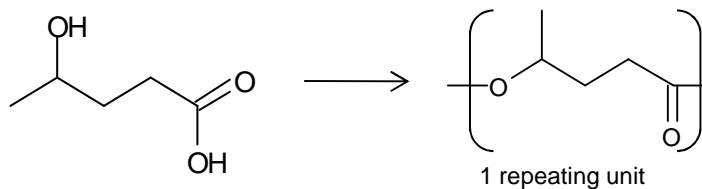
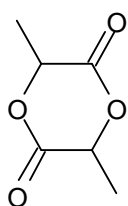
If asked for **type of polymer**: It is polyamide or polyester

Whereas **type of polymerisation** is **condensation**

It is also possible for polyamides and polyesters to form from **one** monomer, if that monomer contains both the functional groups needed to react

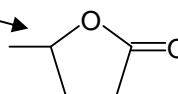


2 lactic acid molecules can also form a ring diester



It is possible for some of these compounds to form various cyclic esters under different conditions from forming the polymer.

You do not need to learn these but may be asked to deduce structures from information given



Chemical reactivity of condensation polymers

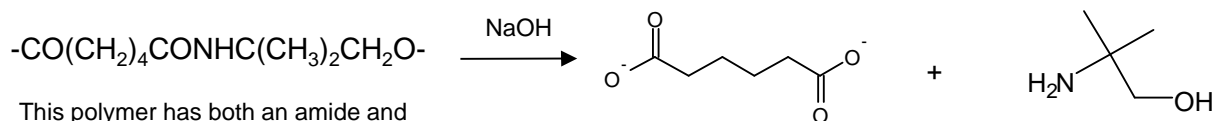
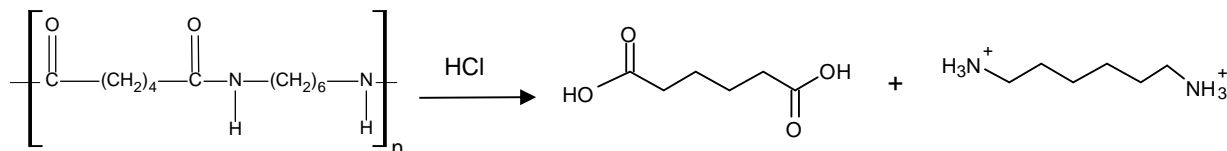
polyesters and polyamides can be broken down by **hydrolysis** and are, therefore, biodegradable

The reactivity can be explained by the presence of **polar bonds** which can attract attacking species such as nucleophiles and acids

Hydrolysis

Polyesters and polyamides can be hydrolysed by acid and alkali

The hydrolysis will result in the original monomers forming- although the carboxylic acid or amine group will be in salt form depending on whether the conditions are alkaline or acidic



This polymer has both an amide and ester link

Condensation polymers may be photodegradable as the C=O bond absorbs radiation.