

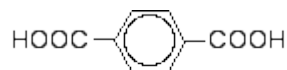
## Polyesters and Polyamides

**Condensation polymerisation** involves the elimination of a small molecule, often water, so empirical formula of polymer is different from that of the monomer.

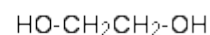
**Note: recall of polyesters, polyamides or their monomers is NOT required.**

### 1. Polyesters

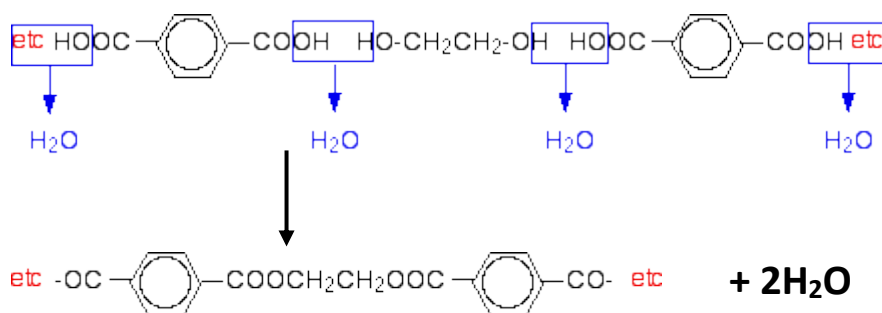
- a) **Example 1 Terylene.** One monomer, **benzene-1,4-dicarboxylic acid** has 2 acid groups. The other, **ethane-1,2-diol** has 2 alcohol groups. As each ester link is made, a water molecule is lost.



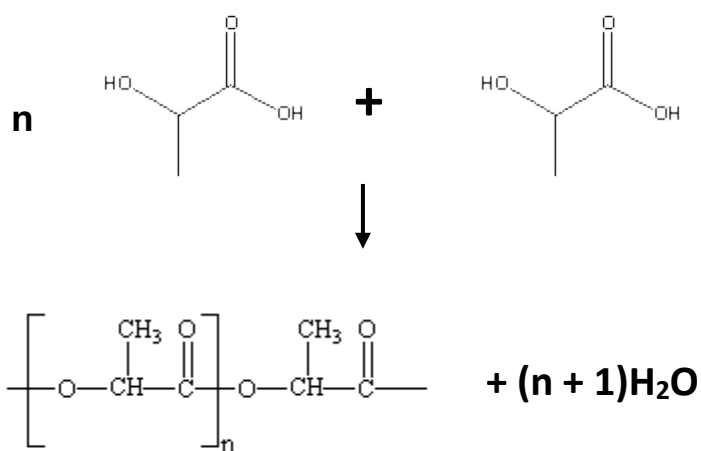
benzene-1,4-dicarboxylic acid



ethane-1,2-diol



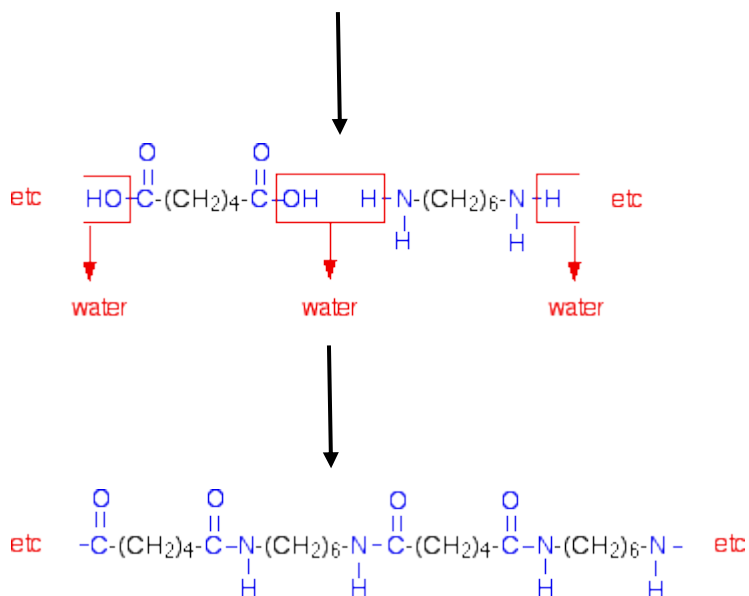
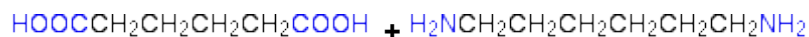
- b) **Example 2: Poly(lactic acid)** from 2-hydroxypropanoic acid (lactic acid). A water molecule is lost as the molecule self polymerises.



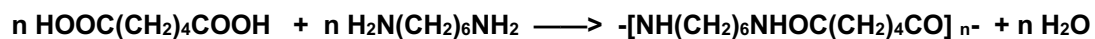
## 2. Polyamides

### a) Example 1

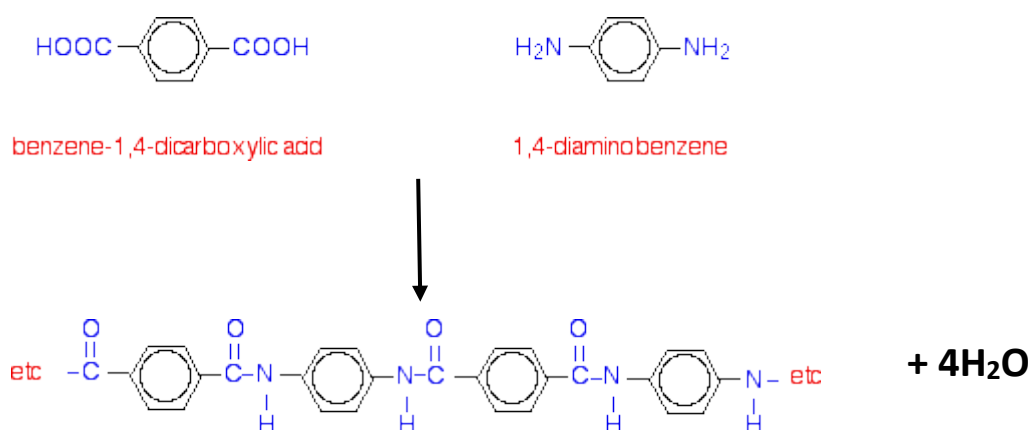
**Nylon-6,6.** 1,6-diaminohexane has 2 amine groups, hexane-1,6-dicarboxylic acid has 2 acid groups. Water is again formed. The chain contains **two** monomer units, arranged **alternately**.



Equation:



b) **Example 2: Kevlar.** The monomers are benzene-1,4-diamine and benzene-1,4-dicarboxylic acid.



**Uses** - Polyesters and polyamides are used as fibres in clothing.

## Comparison of Addition and Condensation Polymerisation

<b>ADDITION</b>	all the atoms in the monomer are used to form the polymer. Atom economy = 100%
<b>CONDENSATION</b>	monomers join up the with expulsion of small molecules not all the original atoms are present in the polymer Atom economy less than 100%

### Given a section of polymer, to deduce the type of polymerisation and the monomer(s):

- If no ester or amide link present, addition polymerisation. Draw C=C bond in repeat unit to obtain the monomer.
- If amide or ester link present, condensation polymerisation. Break C-N or C-O bond and add H and OH to obtain the two monomers.

## Hydrolysis

### Acid and Base hydrolysis of polyesters and polyamides – see hydrolysis of esters (4.1.3) and hydrolysis of proteins (4.2.1)

- Polyesters**  
reflux with  $\text{HCl}_{(\text{aq})}$  produces the alcohol and carboxylic acid.  
reflux with  $\text{NaOH}_{(\text{aq})}$  produces the sodium salt of the carboxylic acid and the alcohol.
- Polyamides**  
reflux with  $\text{HCl}_{(\text{aq})}$  produces the carboxylic acid and salt of the amine.  
reflux with  $\text{NaOH}_{(\text{aq})}$  produces the sodium salt of the carboxylic acid and the amine.