Polymers

Macromolecules

- Macromolecules are made from smaller subunits, such as:
  - Polymers
    - Smaller subunits are the same type of molecules
  - Non-Polymers

Polymers and Repeating Units

- Polymers are made from many **smaller molecules** called **monomers**
- Each small unit within the polymer that repeats itself is a **repeating unit**

Addition Polymerisation of Ethene

Chemical Equation

$$n\ C_2H_4 \rightarrow (-C_2H_4-)n$$

Conditions

- High temperature and pressure

Uses

Plastic bags, cling film, plastic containers.

Condensation Polymerisation

Condensation polymerisation occurs when two monomers with **different functional groups** combine to form a polymer, with the **removal of a small molecule such as water.**

- One monomer that contains the two carboxylic acid functional groups (– COOH), **dicarboxylic acid**
- Another monomer that contains either two alcohol functional groups (– OH), **diol**, or two amine functional groups $–NH_2$, **diamine**

Condensation Polymers

Polyester

- Monomers are linked together by ester linkage

Polyamide

- Monomers are linked together by amide linkage.

Condensation Polymer - Polyester (Terylene)

Polyester is formed when a diol and a carboxylic acid undergo condensation polymerisation.

Polymers - The 'Aftermath' of Plastics

Characteristics of Plastics

- Relatively cheap
- Easily moulded into various shapes
- Light, tough and waterproof
- Durable (resistant to decay, rusting and chemical attack)

Problems Caused by Plastics

Environmental Problems

Water Pollution

- Plastics in the sea **endanger marine animals,** often **mistaken for food** and harmed by them.
- Plastics also **clog up rivers and drains,** becoming breeding grounds for mosquitoes, spreading diseases like **dengue**.

Air Pollution

- Plastics are mostly flammable. When incinerated, plastics **produce poisonous and greenhouse gases.**

Recycling of Plastics

Physical Method

Pre-treatment of Plastic Waste

- Sort by different methods (manual/density sorting)
- Wash to remove contaminants
- Shredding or grinding to smaller pieces.

Mechanical Recycling

- After pre-treatment, small pieces of plastics such as poly(ethene), PE, are melted, cooled, pulled into long, thin strands, and cut into pellets.

Chemical Method

Cracking

- Plastic waste can undergo cracking to form **short chains of alkanes and alkenes**
- Either thermal cracking or catalytic cracking can be done to obtain such products.
    - Short-chain alkanes can be used as fuels
    - Short-chain alkenes may be used to make other useful chemicals through polymerisation.

Deploymerisation

- A process in which polymers are broken down into their monomers

Acid Hydrolysis

Polyesters can be **hydrolysed** (broken down by water) to form the original monomers. This is done by **warming** the polyester with an acid catalyst.