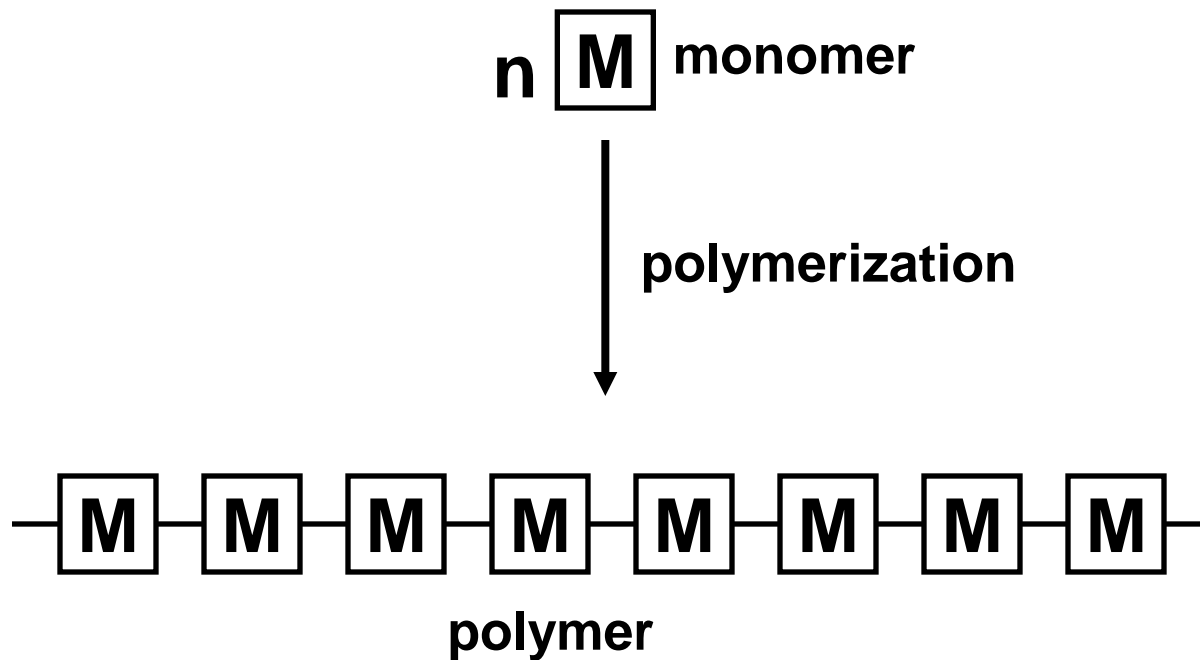


CHAPTER 13: POLYMERS

POLYMER

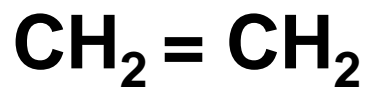
- A large molecule made up of many repeating unit.



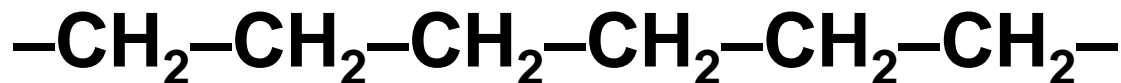
MONOMER

- The simple starting compound from which a polymer is made.

monomer = ethylene



polymerization



polymer = polyethylene

Polymerization – The process of joining monomers together

HOMOPOLYMERS

- A polymer made up of identical (same) monomers.

A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A

EXAMPLE:

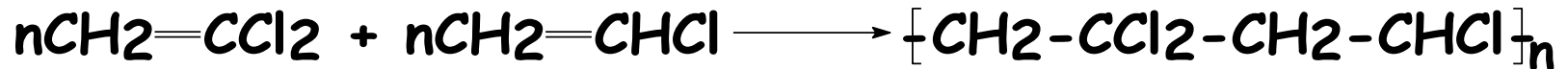
-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-CH₂-

COPOLYMER

- A polymer made up of two or more different monomers.

A-B-A-B-A-B-A-B-A-B-A-B-A-B-A-B-A

EXAMPLE:



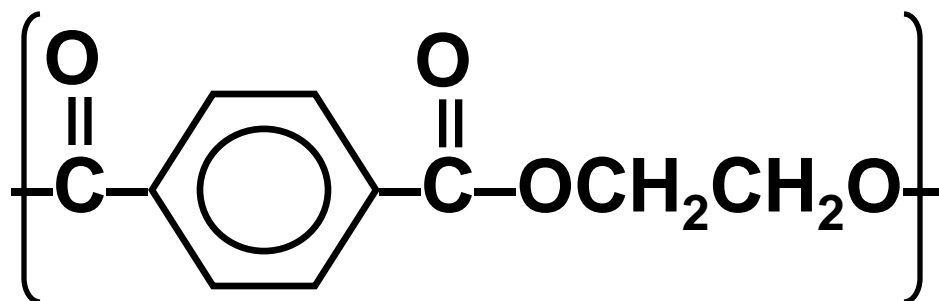
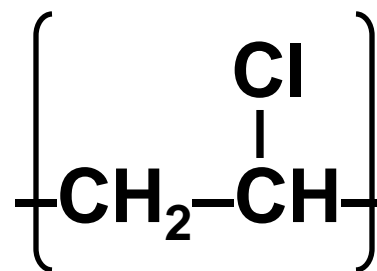
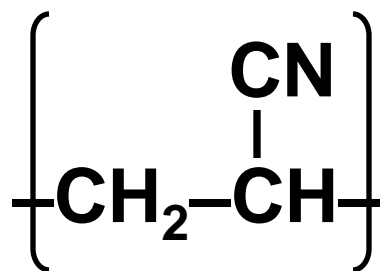
1,1-dichloroethene 1-chloroethene

Saran®

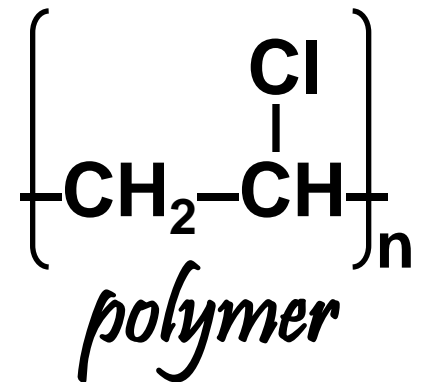
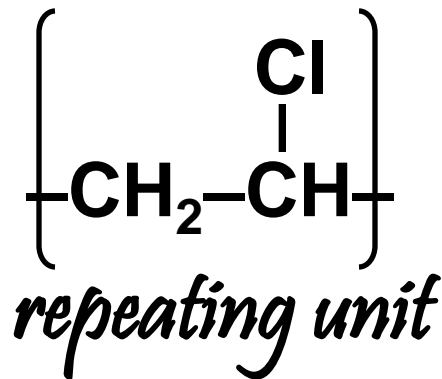
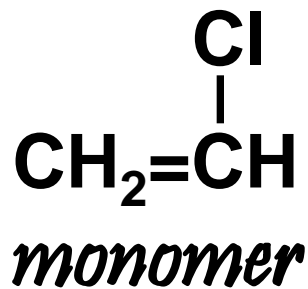
REPEATING UNIT

- The smallest molecular fragment that contains all non repeating structural features of the chain.

EXAMPLE:



Keep in mind!

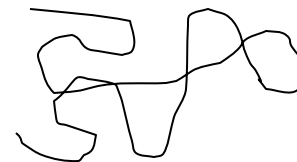


LINEAR POLYMER

- consist of monomers that are linked in straight and long chain
 - can be folded back upon themselves in a random fashion
 - is recycleable because it is soft and can be reformed when heated



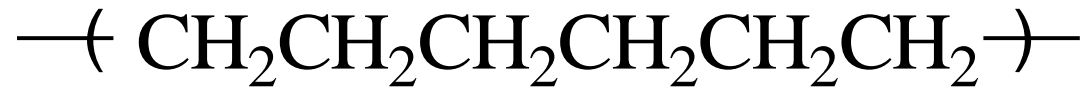
Monomers link together in a straight chain



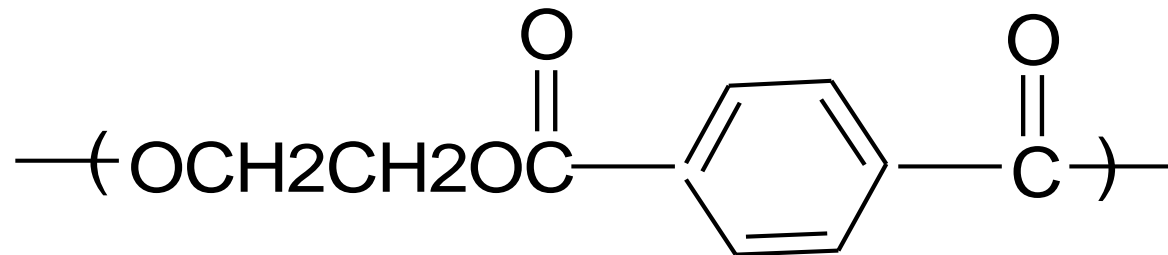
Folded linear polymer in a random fashion

EXAMPLE:

- Polyethylene
- Polyester



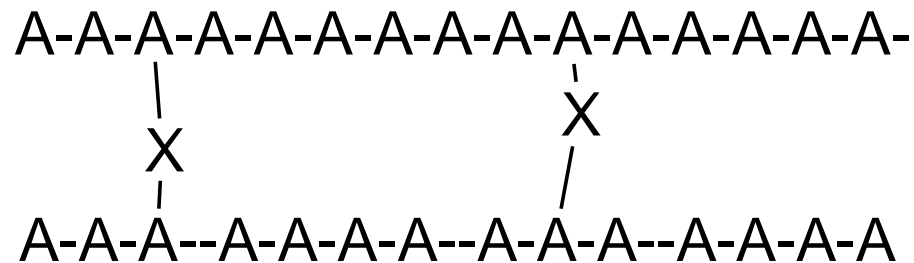
Polyethane



Polyester

CROSS-LINKED POLYMERS

- **contain branches that connect linear polymer chain**
 - **is harder (rigid) and more elastic polymer compared to linear polymer**
 - **can not be remelted or remolded again**



Long polymer chain cross-linked by branched

TYPES OF POLYMERS

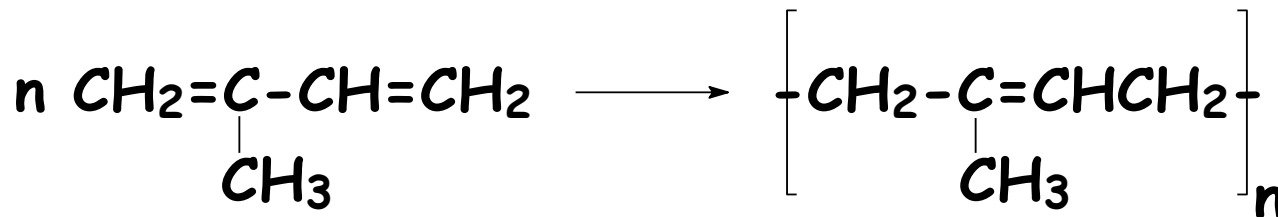
- Can be divided into two types:
 - natural polymers
 - synthetic polymers

NATURAL POLYMERS

- are an extremely large molecules occurred naturally.

EXAMPLE:

- **Protein:** built from amino acids
- **Carbohydrate** such as starch is also a polymer
- **Rubber.** Monomers for rubber is 2-methyl-1,3-butadiene also known as **isoprene**



isoprene

cis-polyisoprene

SYNTHETIC POLYMERS

- Polymers that are prepared in industries from monomers that have gone through **polymerisation** process

EXAMPLE:

Toys, drinking bottles, styrofoams and fabrics

- Synthetics polymers can be classified base on:
 - **cross-linked polymer**
 - **linear polymer**

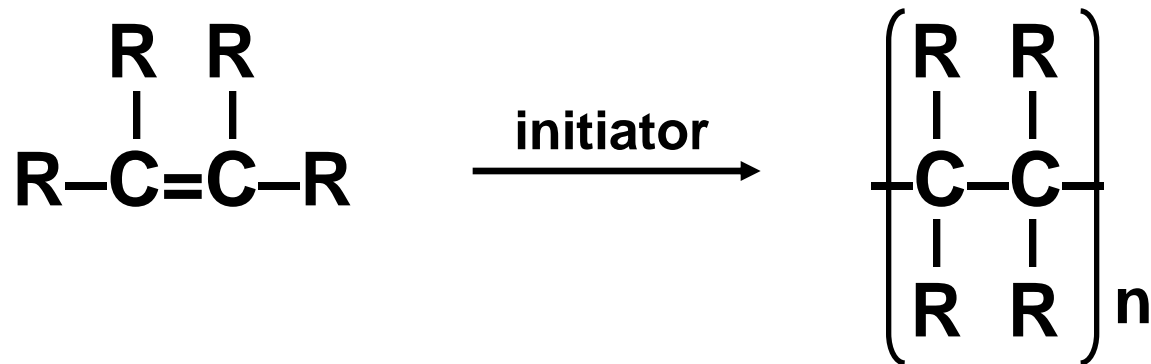
TYPE OF POLYMERIZATION

- **2 types of chemical reaction that are use to form polymer are**
 - **Addition polymerization**
 - Reaction to produce **polyethene**
 - Reaction to produce **polyvinyl chloride**
 - Reaction to produce **polystrene**
 - **Condensation polymerization**
 - **Polyamides**
 - Formation of Nylon 6,6
 - Formation of Nylon 6
 - Formation of Kevlar
 - **Polyester**
 - Formation of Dacron
 - Formation of Terylene

ADDITION POLYMERIZATION

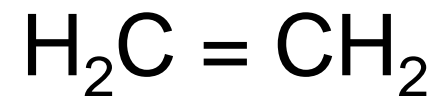
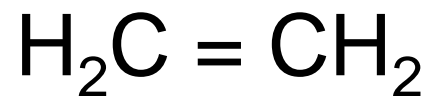
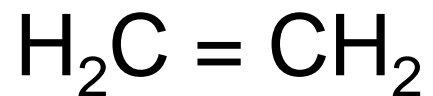
- **Involved the addition reaction of unsaturated monomers without elimination of any small molecule**
- **Always involves the polymerization of monomers which have double bond within the monomers**
- **Peroxide is used as initiator in addition polymerization**

- Vinyl monomers are commonly used:
 - Ethylene (ethene) – $\text{CH}_2=\text{CH}_2$
 - Substituted ethylene – $\text{CH}_2=\text{CHR}$

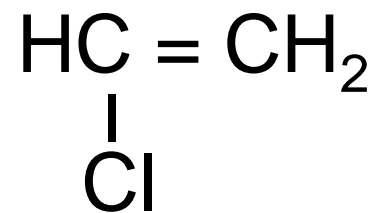
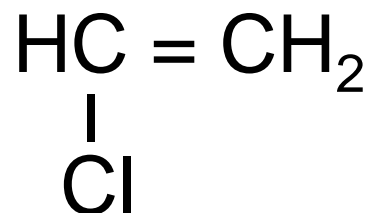
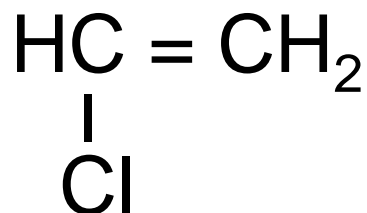


R can be H, alkyl, aryl, halogens, CN, OH, COOR, etc.

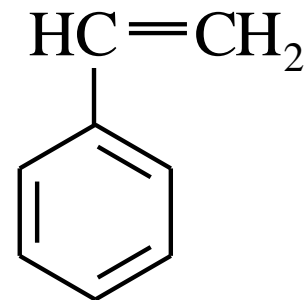
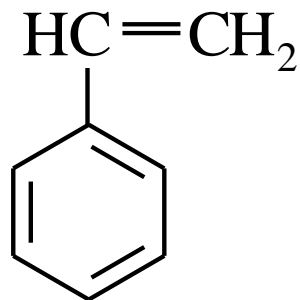
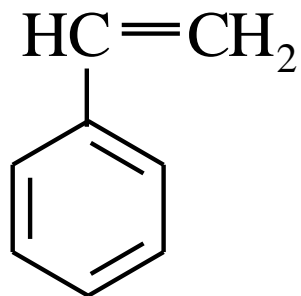
FORMATION OF POLYETHENE



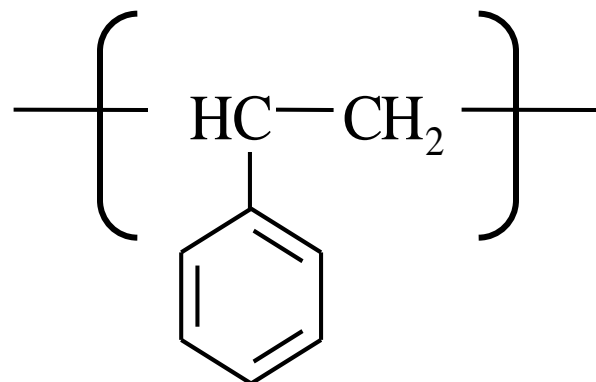
FORMATION OF POLYVINYL CHLORIDE



FORMATION OF POLYSTYRENE



Formation of monomer

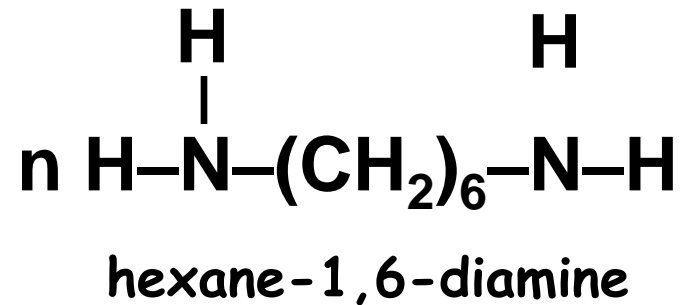
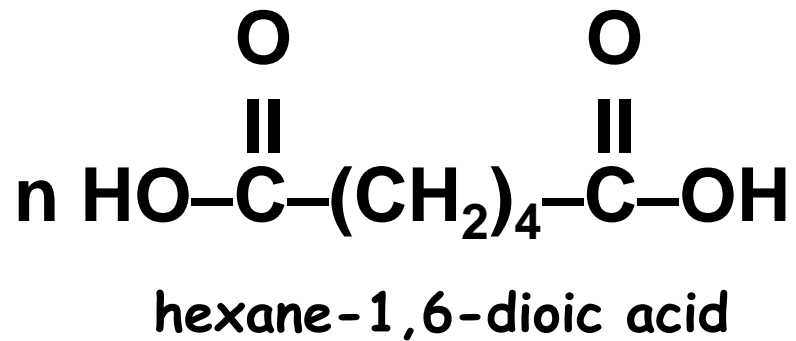


CONDENSATION POLYMERIZATION

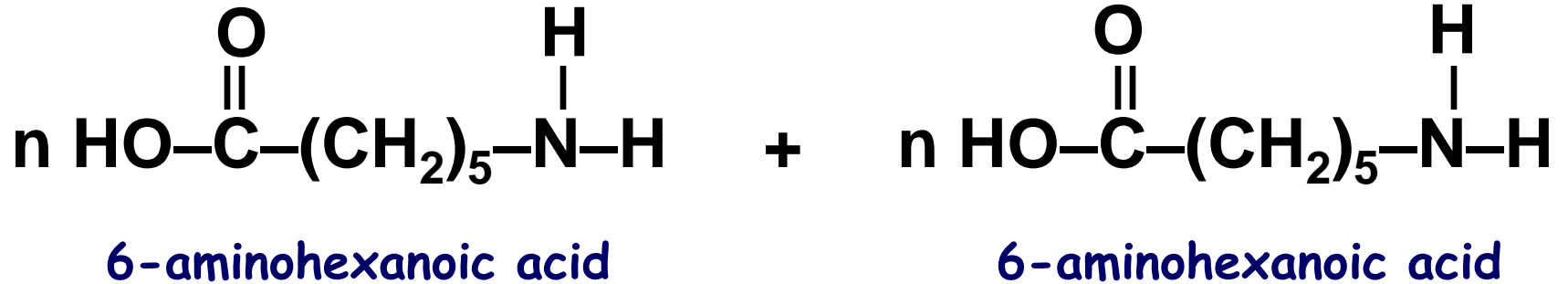
- Condensation polymers are formed when two different monomers combine together with elimination of a small molecule such as water, or methanol to form a polymer
- The monomers involves in this polymerization must have at least two identical or different functional group in the molecule.
- When a carboxylic acid with two **-COOH group** reacts with an amine with two **-NH₂ groups**, a **polyamide** is formed.
- When a carboxylic acid with two **-COOH group** reacts with an alcohol with two **-OH groups**, a **polyester** is formed

FORMATION OF POLYAMIDES

NYLON 6,6



NYLON 6

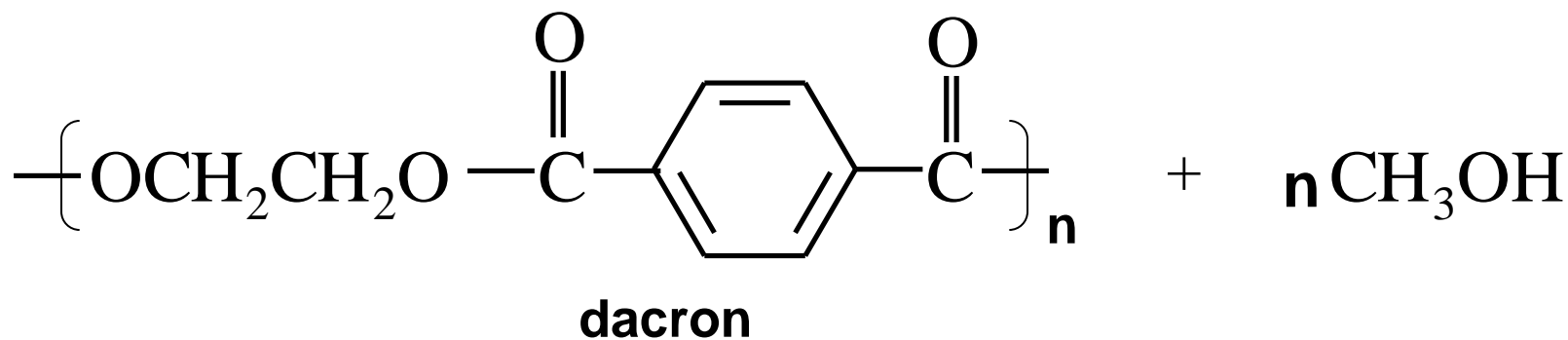
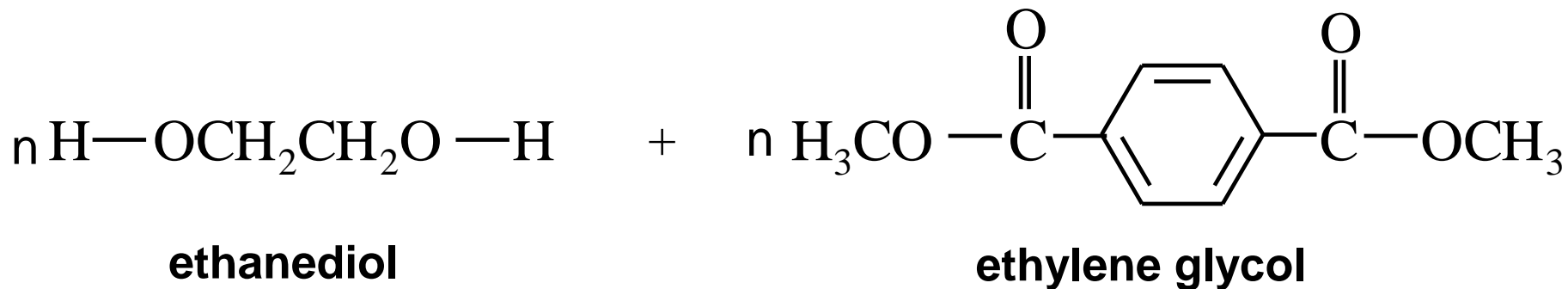


KEVLAR

FORMATION OF POLYESTER

TERYLENE

DACRON

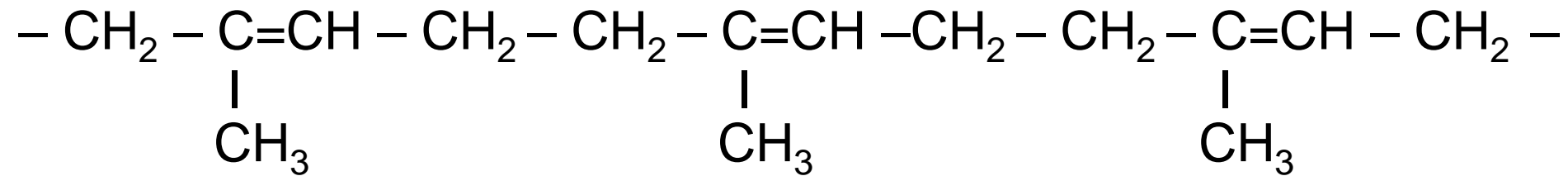


USES OF SYNTHETIC POLYMER

	Type of polymer	Example
1	Polyethane	Drinking bottle
2	Polyvinyl chloride	Wire covering
3	Polystyrene	Toys, food container
4	Nylon 6	Textile
5	Nylon 6,6	Sweater
6	Kevlar	Bullet proof vest
7	Dacron	Fabric
8	Terylene	Fiber-optic material

Exercise 1:

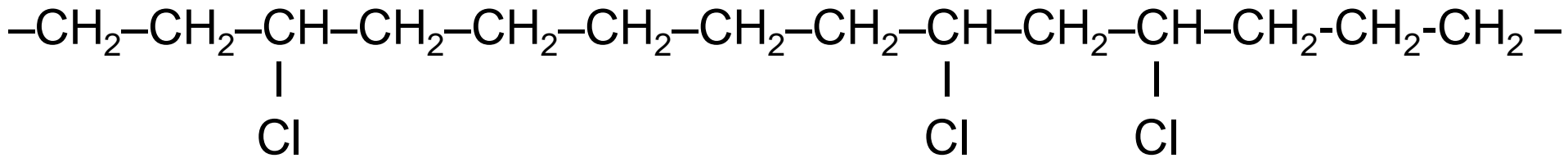
Identify the repeating units in the following polymers and classify them as homopolymers or copolymers.



Answer:

Exercise 2:

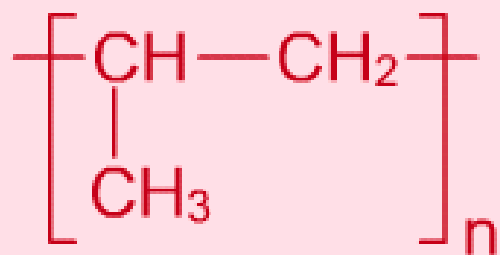
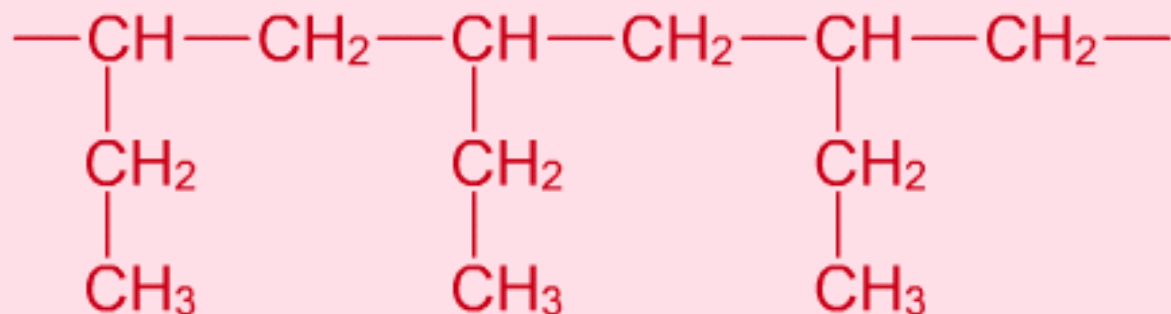
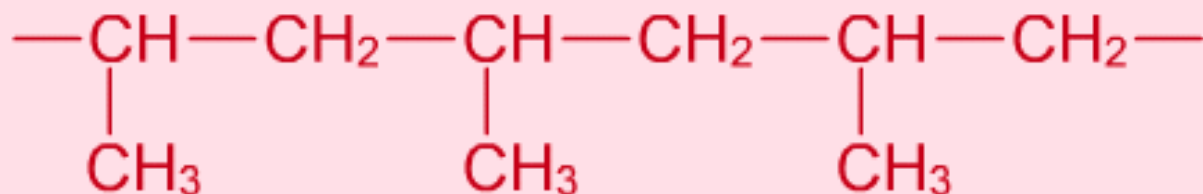
Identify the repeating units in the following polymers and classify them as homopolymers or copolymers.



Answer:

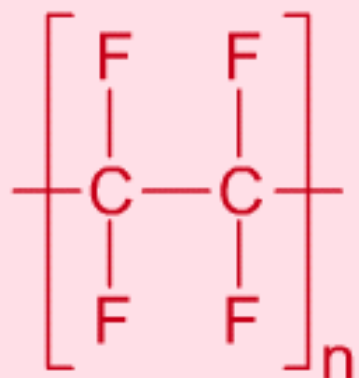
Exercise 3:

Choose the structure of polypropylene (or polypropene), a polymer obtained from the addition polymerisation of propene.



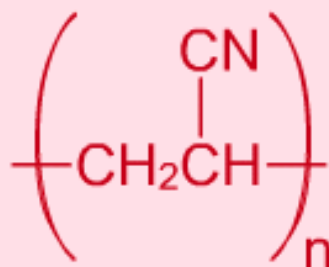
Exercise 4:

Choose the structure of teflon, a polymer obtained from the addition polymerisation of tetrafluoroethene.

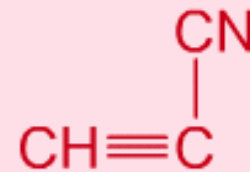
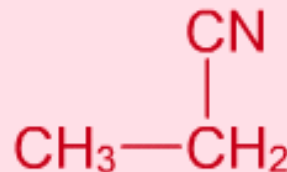
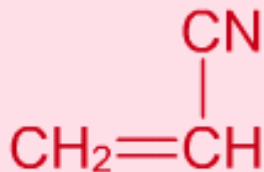


Exercise 5:

Orlon has the following formula:

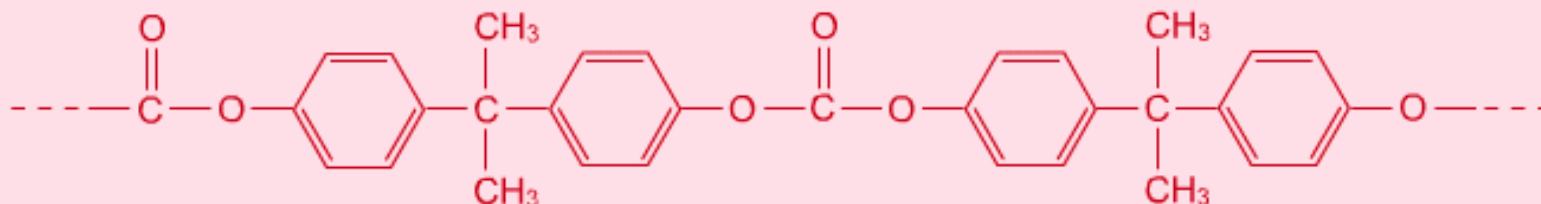


What is the structure of its monomer?
Choose the correct answer.



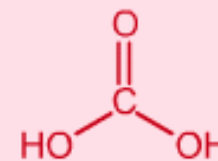
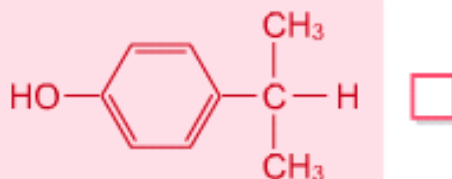
Exercise 6:

Consider the following polymer:

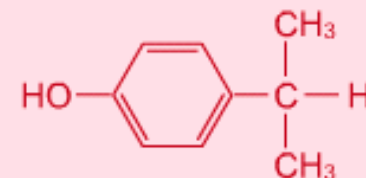
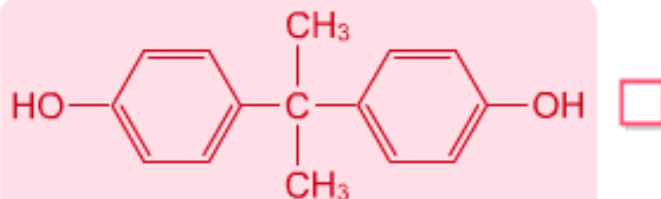


explanation

Classify the polymer:



and determine the substrates.



check



reset

The End....

Keep in mind!

- General structural formula:

