Today's Goal

Polymers

उम्मीद

Monomer units → Polymers

macromolecules
(Higher molecular mass)
($10^3 - 10^7$ u)

Polymers

Classification based on– 1. Source

1. **Natural polymers -found in plants and animals**

(A) BIODEGRADABLE

- Starch
- Protein
- Cellulose
- Glycogen

(B) NON BIODEGRADABLE

- Rubber
- Resins

2. **Semi synthetic polymers –**

(A) Cellulose Derivative

- Cellulose acetate (Rayon)
- Cellulose Nitrate

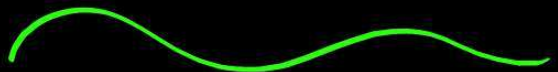
(B) Vulcanised Rubber

3. **Synthetic polymers –**

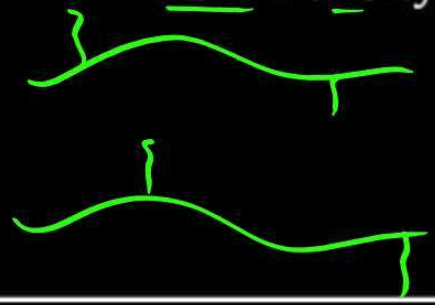
- Polythene (Plastic)
- Buna-s
- Nylon-66

2. Structure

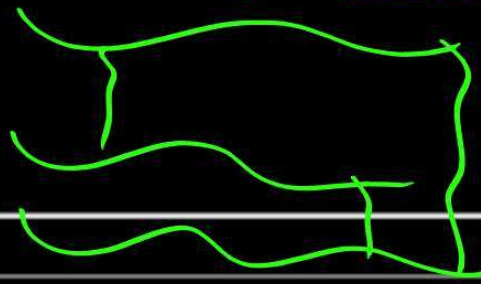
1. **Linear Polymer**
   - High Density Polythene (HDP)
   - Polyvinyl chloride (PVC)



2. **Branched Polymer**
   - Low Density Polythene (LDP)



3. **Cross linked Polymer or network polymer**
   - Bakelite
   - Melamine
   - Urea formaldehyde



3. Mode of Polymerisation

1. Additional polymers (chain growth)

Polymerisation of

1. Homo -polymer (Same molecules)

- Polythene
- Polystyrene
- Poly vinyl Chloride (PVC)
- Poly acrylo nitrile (PAN, Orlon, Acrilan)
- Teflon
- Natural Rubber (poly cis-isoprene)
- Synthetic rubber (Neoprene)

2. Co-polymers (different molecules)

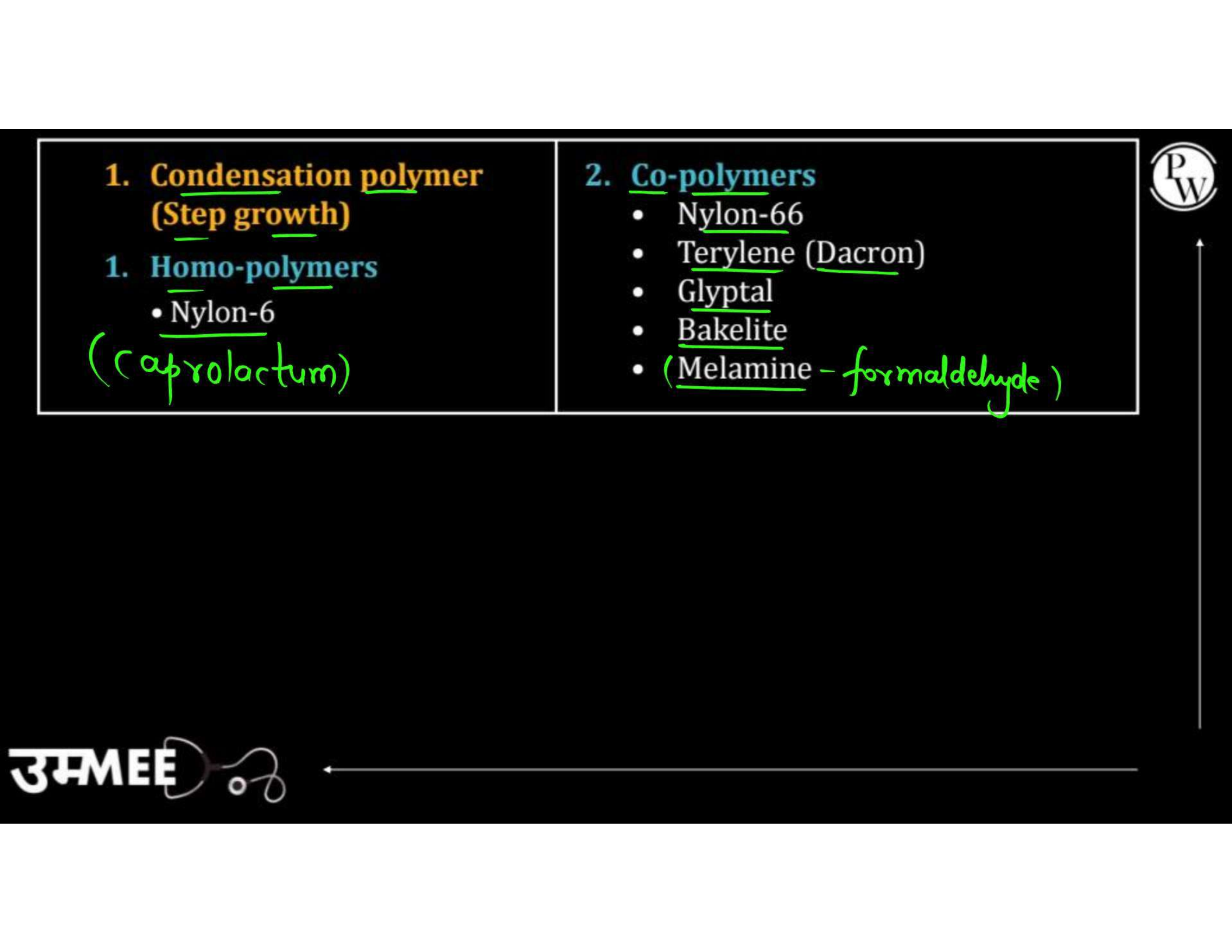
- Buna-S
- Buna-N

1. **Condensation polymer (Step growth)**

1. **Homo-polymers**
   - Nylon-6

(caprolactum)

2. **Co-polymers**
   - Nylon-66
   - Terylene (Dacron)
   - Glyptal
   - Bakelite
   - (Melamine – formaldehyde)



4. Intermolecular forces

1. Elastomers	2. Fibres	3. Thermoplastic	4. Thermo setting
• Natural Rubber • Vulcanised Rubber • Buna-N • Buna-S • Neoprene (Synthetic Rubber)	• Polyamides • Polyester	• Polystyrene • PVC • Polythene	• Bakelite • Melamine • Urea–formal-dehyde resins

Strength – thermosetting(4) > Fibers (2) > Thermoplastic (3) > Elastomers(1)

$n\,CH_2=CH_2 \longrightarrow \{CH_2-CH_2\}_n$

Mechanism of polymerisation

Peroxide

Chain initiation

$$Ph-\overset{O}{\overset{\|}{C}}-O\}:O-\overset{O}{\overset{\|}{C}}-Ph \longrightarrow 2\,Ph-\overset{O}{\overset{\|}{C}}-O^{\bullet}$$

$$Ph\}\cdot\overset{O}{\overset{\|}{C}}-O^{\bullet} \longrightarrow Ph^{\bullet} + CO_2$$

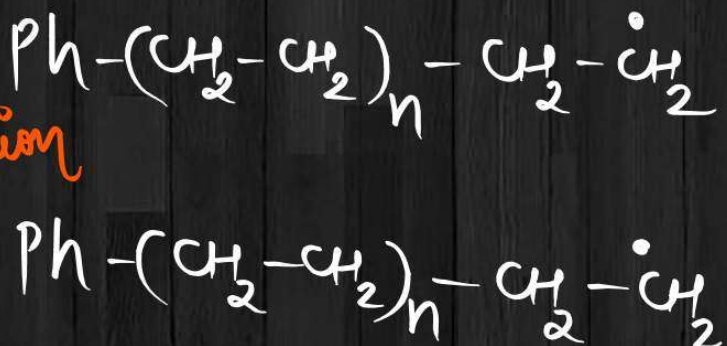
Chain propagation

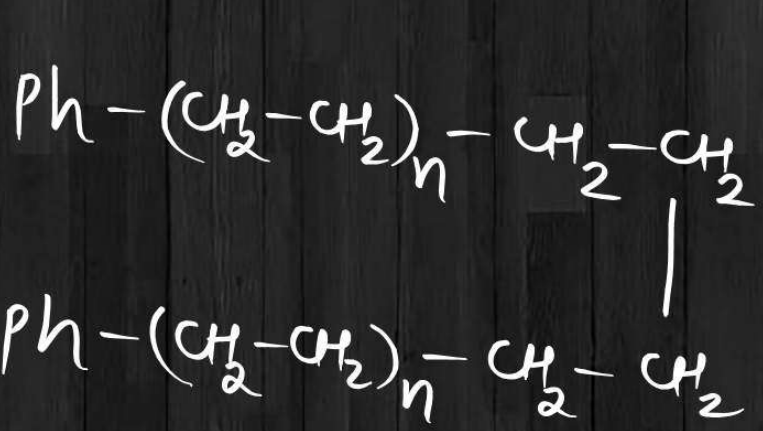
$$Ph^{\bullet} + CH_2=CH_2 \longrightarrow Ph-CH_2-CH_2^{\bullet}$$

$$Ph-CH_2-CH_2^{\bullet} + CH_2=CH_2 \longrightarrow Ph-CH_2-CH_2-CH_2-CH_2^{\bullet}$$

$$Ph-(CH_2-CH_2)_n-CH_2-CH_2^{\bullet}$$

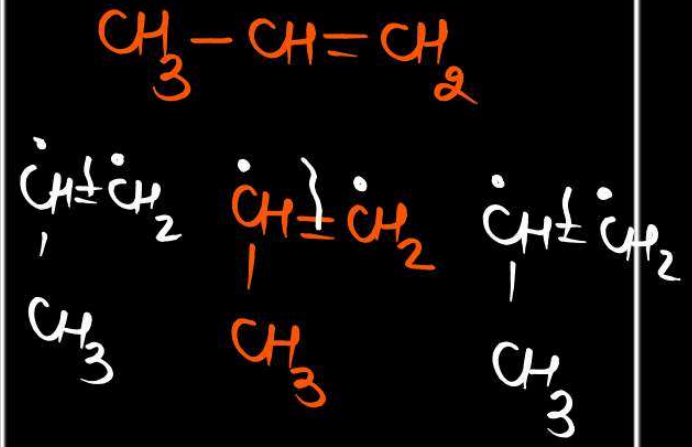
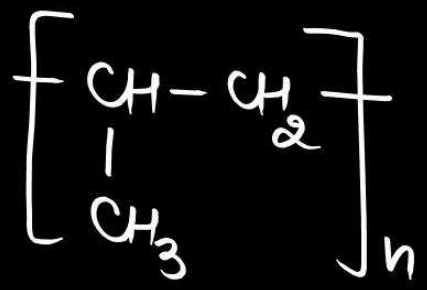
chain termination



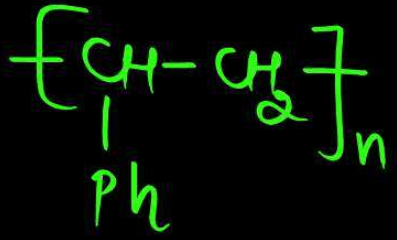


polymer 

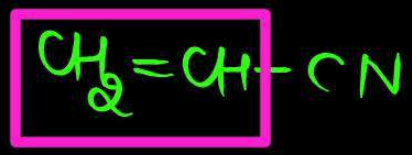
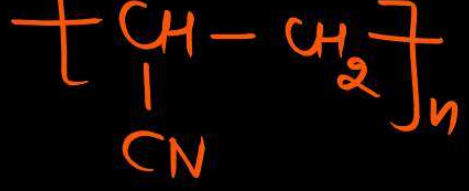
Examples of Addition Polymers

MONOMERS	POLYMERS	USES
1. Propene 	Polypropene 	Toys, pipe, fibre , ropes

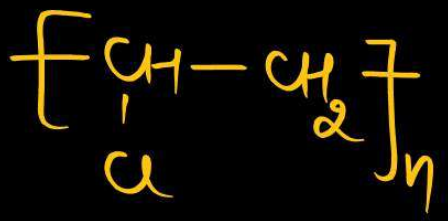
Examples of Addition Polymers

2. Styrene 	**Polystyrene** 	Toys, radio and TV cabinets , insulator ,wrapping material

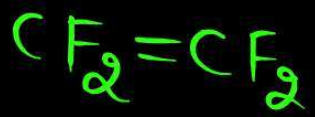
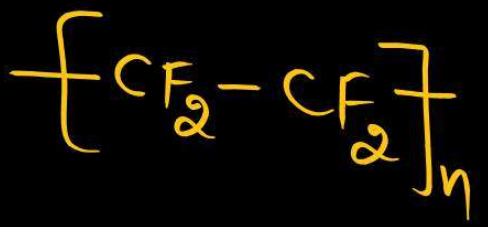
Examples of Addition Polymers

3. **Acrylonitrile** (vinyl cyanide) 	**Poly acrylo nitrile (Acrilan, orlon)** (PAN) 	Substitute for wool in making commercial fibers

Examples of Addition Polymers

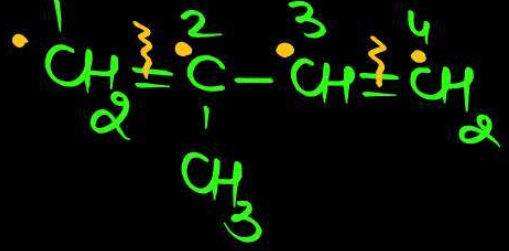
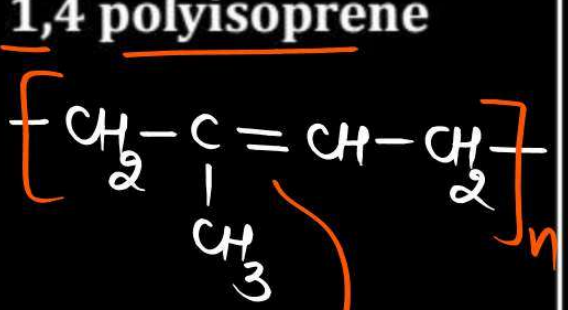
4. Vinyl Chloride 	**Polyvinyl chloride** 	Rain coats, hand bags, water pipes , vinyl flooring

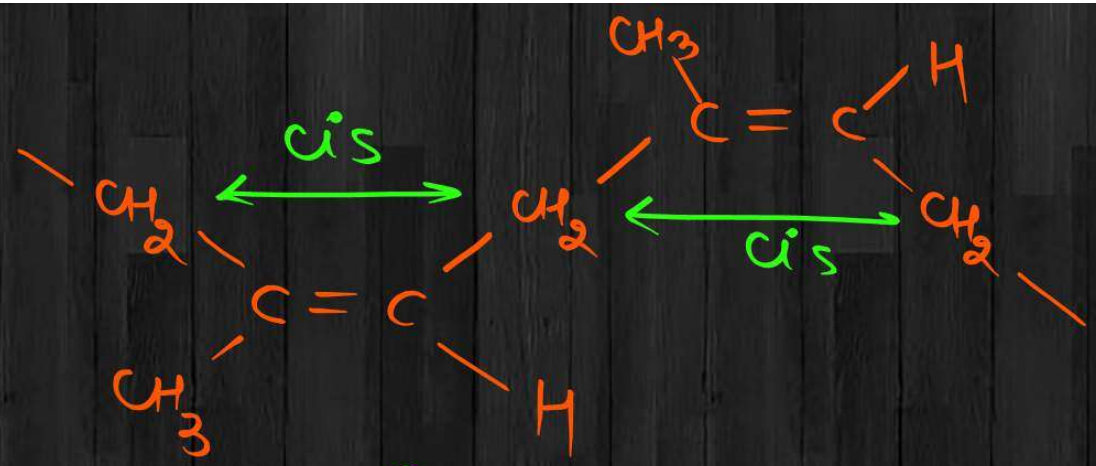
Examples of Addition Polymers

5. Tetrafluoroethene 	**Teflon** 	Non stick surface coated utensils

Examples of Addition Polymers

2-methyl-1,3-butadiene

6. Isoprene	Natural rubber (Cis-1,4 polyisoprene	Rubber latex → colloidal dispersion of Rubber in water
		

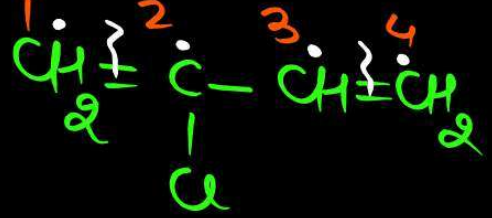
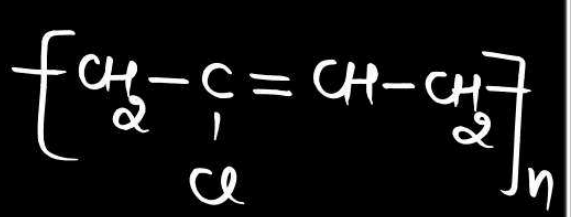


All - cis config. ⇒ Natural rubber

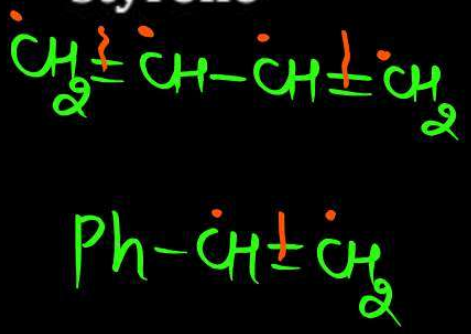
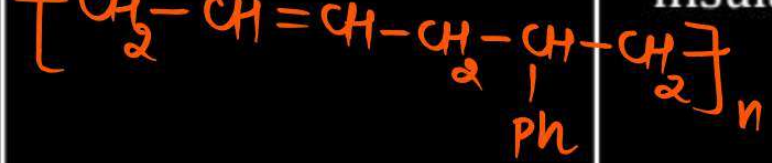
All - trans config ⇒ Gutta percha

Examples of Addition Polymers

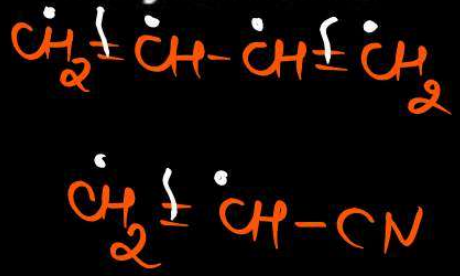
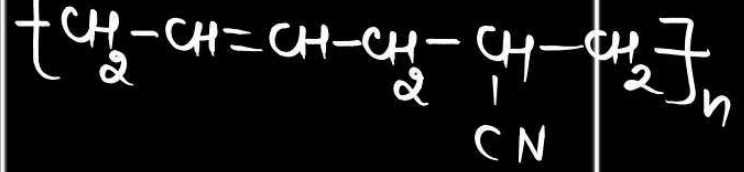
2-chloro-1,3-butadiene

7. Chloroprene 	**Neoprene** 	Conveyer belts gaskets and hoses It is superior resistance to vegetable and mineral oils

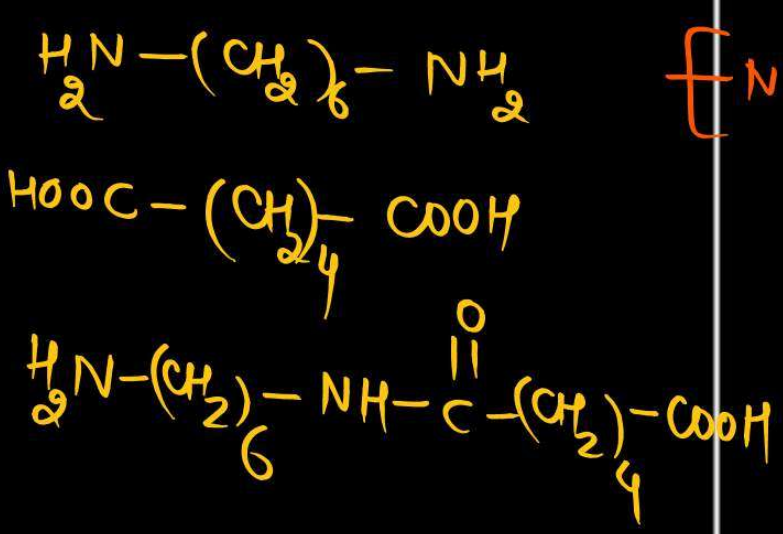
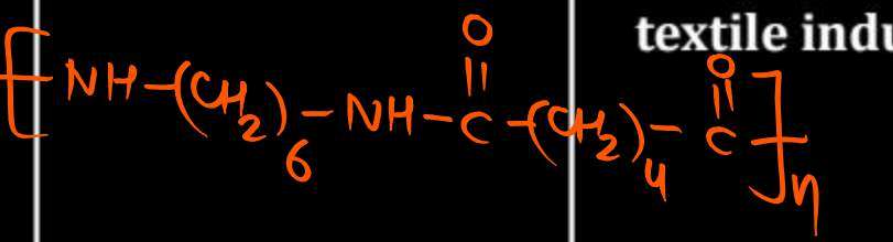
Examples of Addition Polymers

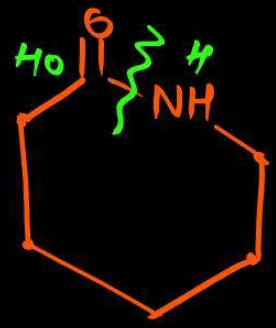
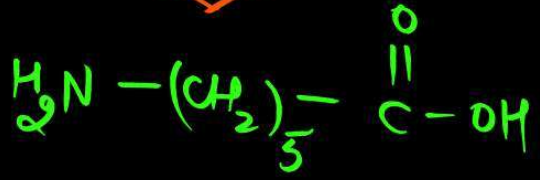
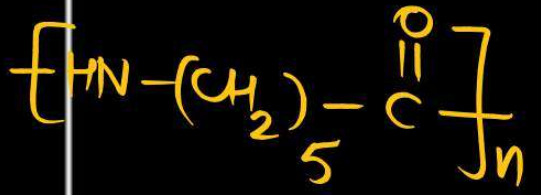
8. 1,3 Butadiene + styrene 	**BUNA-S** 	Auto tyres, footwear, floor tiles, cable insulation

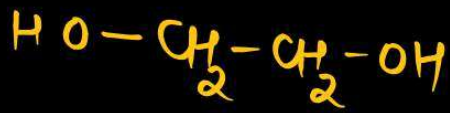
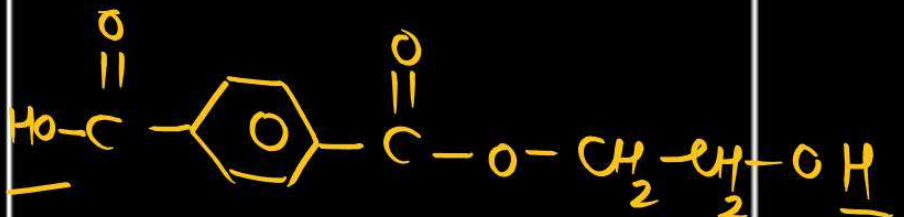
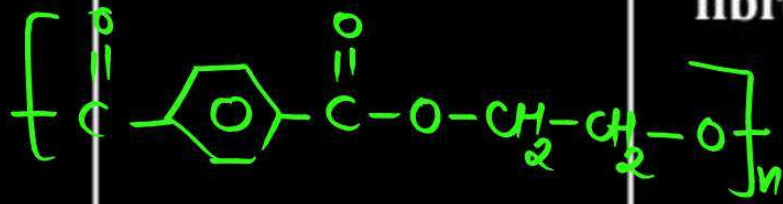
Examples of Addition Polymers

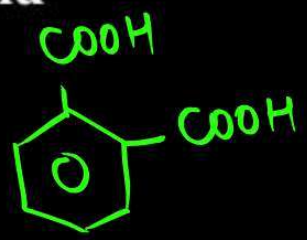
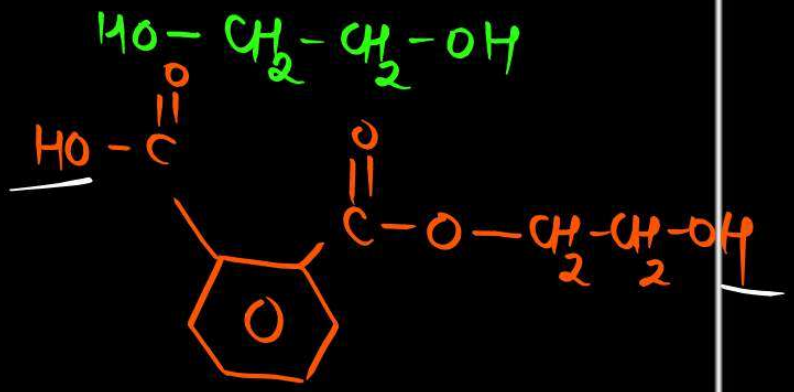
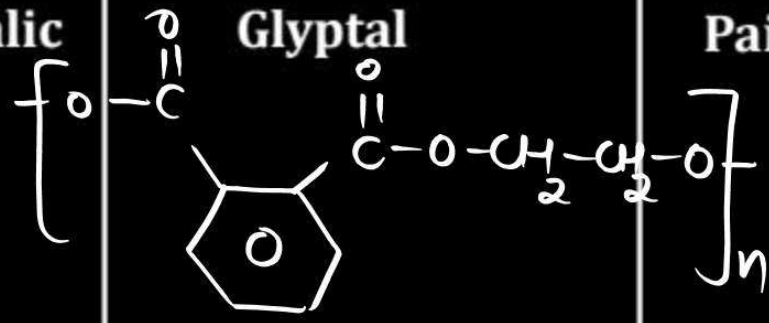
9. 1,3 Butadiene + Acrylonitrile  In peroxide catalyst	**BUNA-N** 	Oil seals and tank lining It is resistant to petrol , lubricant oil and organic solvent

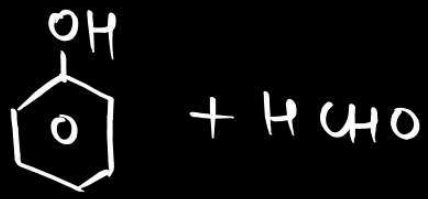
Example of Condensation Polymers

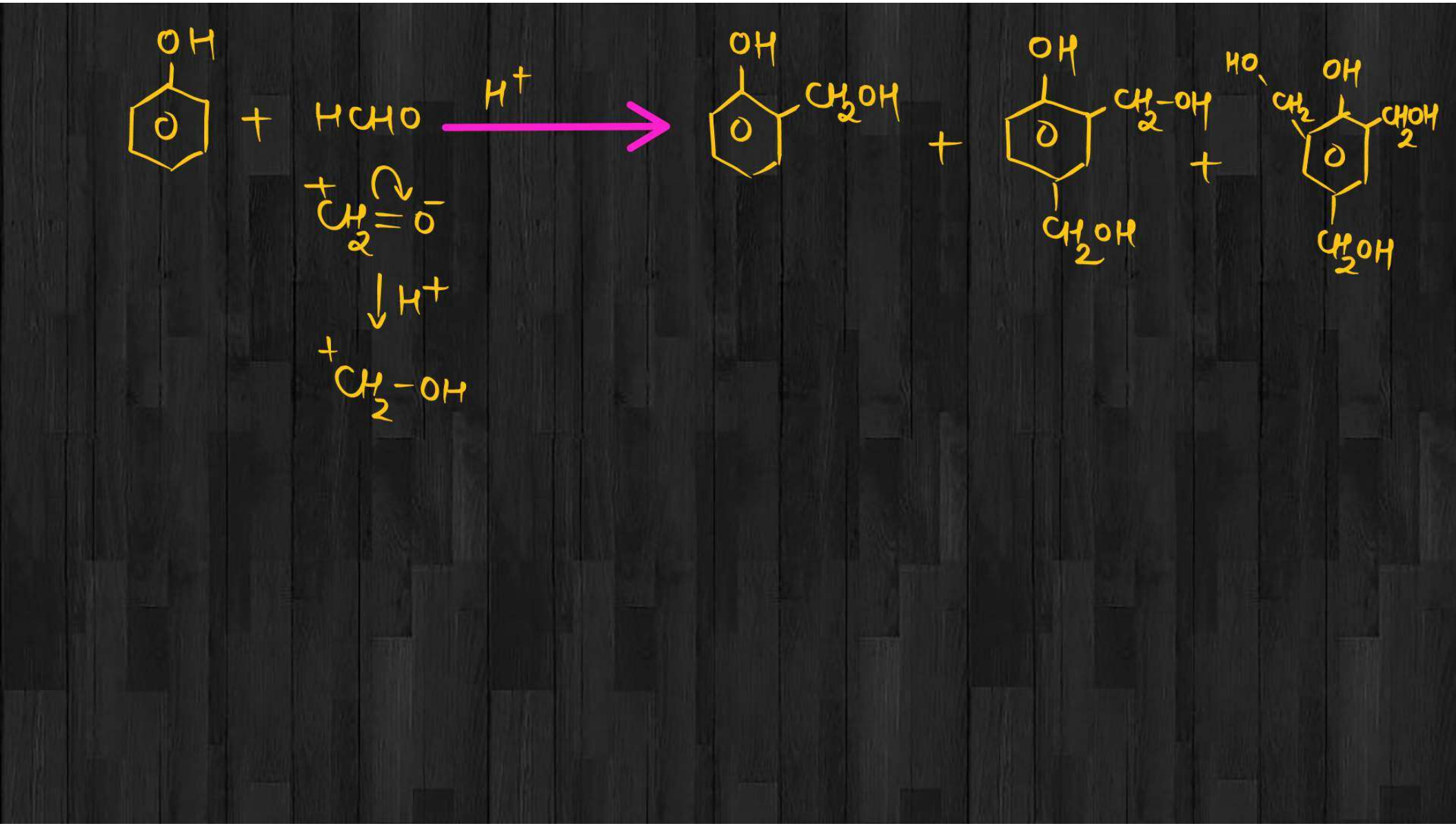
MONOMERS	POLYMERS	USES
1. Hexamethylenediamine + Adipic acid 	Nylon-66 	Sheets, bristles for brushes and in textile industry At 553K and high pressure

MONOMERS	POLYMERS	USES
2. Caprolactam  	Nylon-6 	Tyre cards, fabrics and ropes At 533K-543K in water

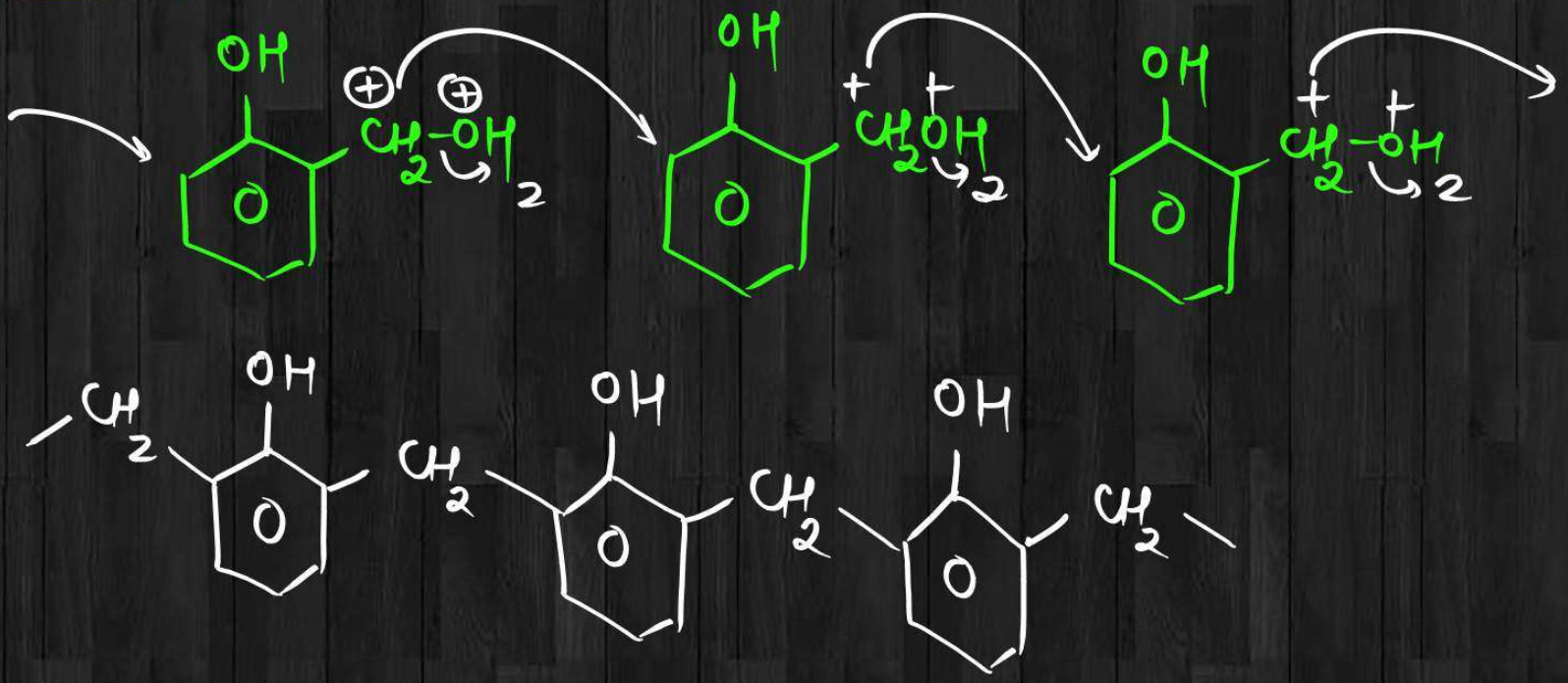
MONOMERS	POLYMERS	USES
3. Ethylene glycol + Terepthalic acid   	Terylene (Dacron) 	Safety helmets and cotton & wool fibre At 420K-460K Catalyst Zinc acetate + $Zn(OCOCH_3)_2$ Antimony trioxide Sb_2O_3

MONOMERS	POLYMERS	USES
4. Ethylene glycol + Pthalic acid  	Glyptal 	Paint and lacquers

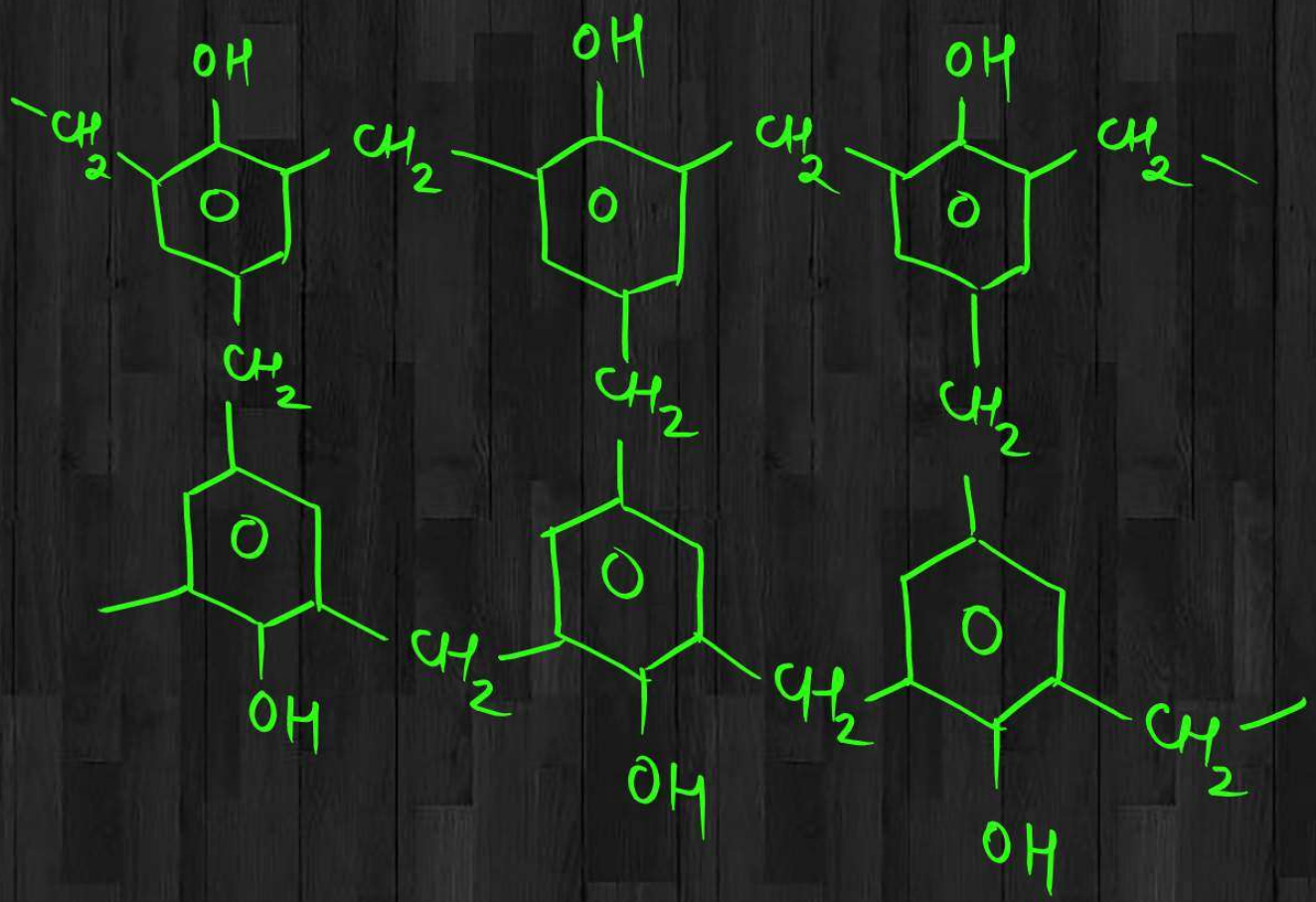
MONOMERS	POLYMERS	USES
5. Phenol + Formaldehyde 	Bakelite	Combs, Phonograph, electrical switches, handles of utensils Computer discs

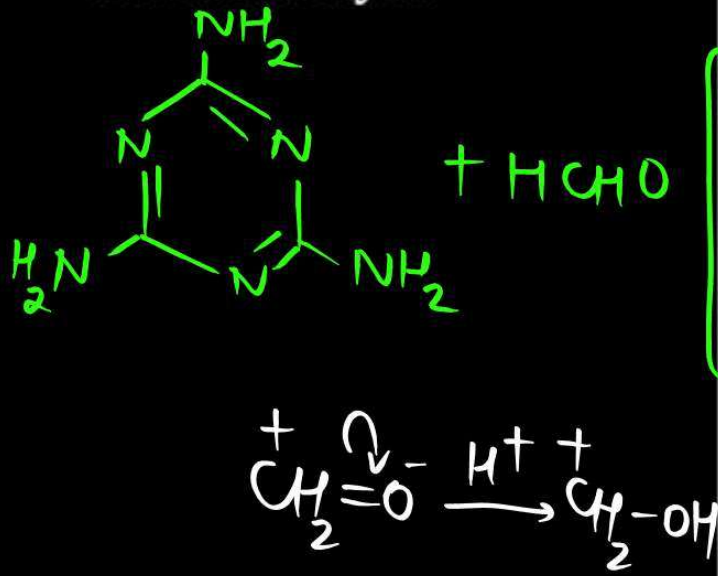

OH
HCHO
H+
CH2OH
CH2-OH
HO
CH2
CHOH2
CH2OH
CH2OH
+CH2=O
H+
+CH2-OH

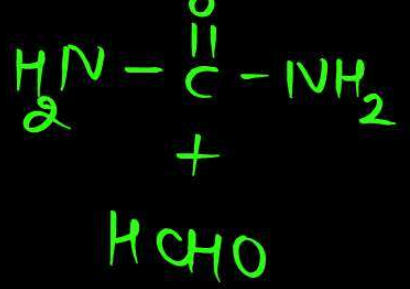
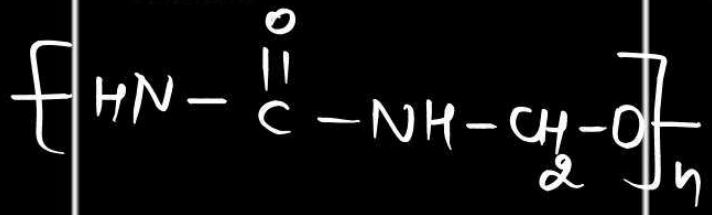
Novolac Linear



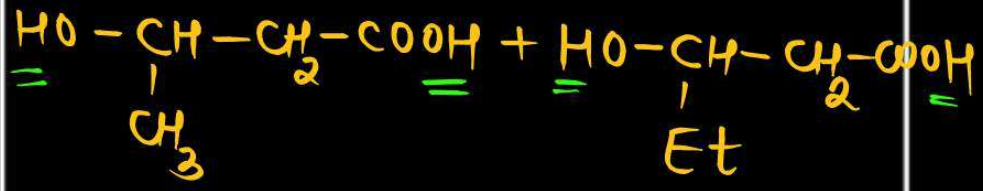
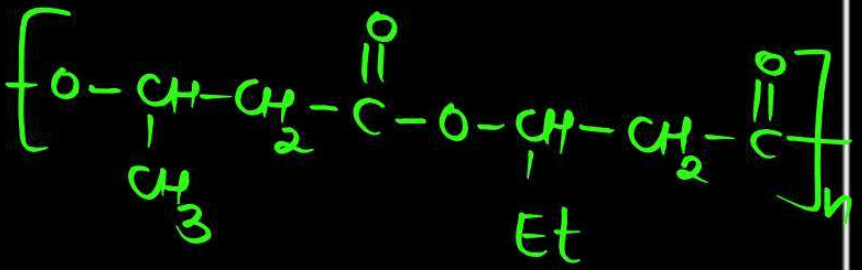
Bakelite cross Linked

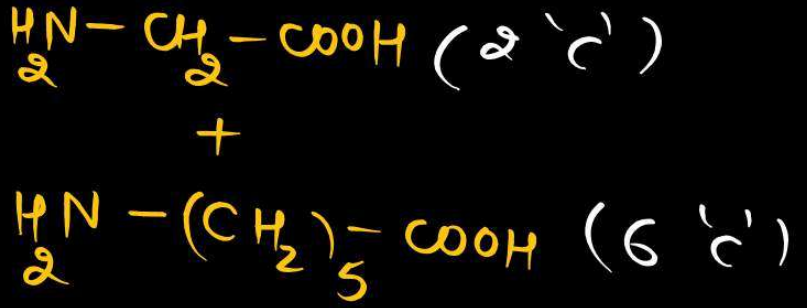
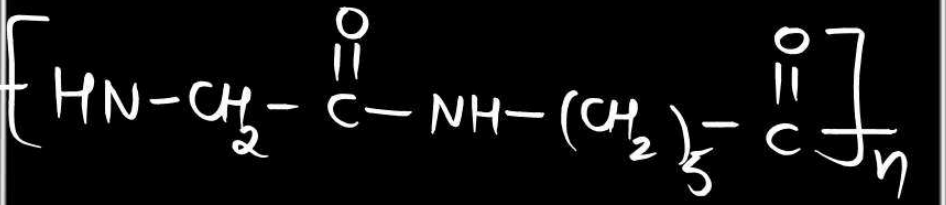


MONOMERS	POLYMERS	USES
6. Melamine + Formaldehyde 	Melamine formaldehyde Resin 	Unbreakable crockery

MONOMERS	POLYMERS	USES
7. Urea + formaldehyde 	Urea formaldehyde resin 	Unbreakable cups and laminated sheets

Example of Biodegradable Polymers

MONOMERS	POLYMERS
1. 3- Hydroxy butanoic acid + 3-Hydroxy pentanoic acid 	PHBV (Poly βHydroxy) butyrate-CO- β Hydroxy Valerate 

MONOMERS	POLYMERS
2. Glycine + Amino Caproic Acid 	Nylon-2,6 

DDT is non biodegradable polymer

Vulcanisation of Rubber

S Linkage

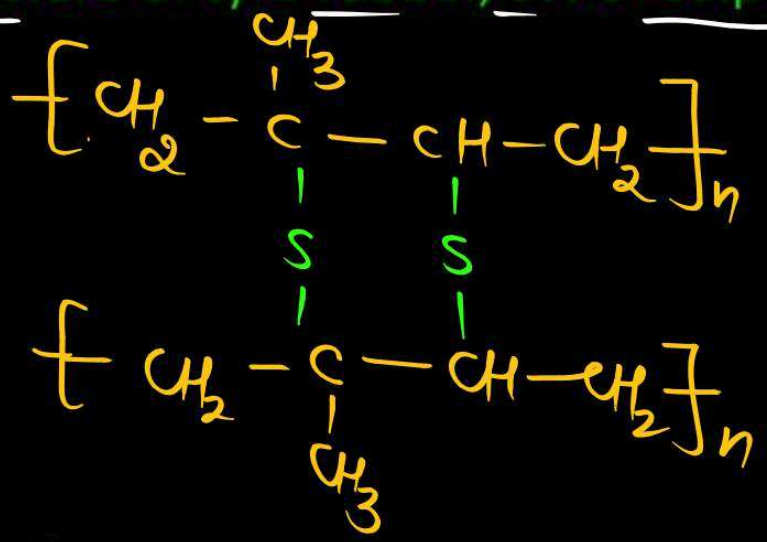
Why vulcanisation???

- Natural rubber becomes soft at high temperature (>335 K) and brittle at low temperatures (<283K)
- shows high water absorption capacity.
- It is soluble in nonpolar solvents and is non-resistant to attack by oxidizing agents.

To improve upon these properties vulcanisation is carried out

Vulcanisation of Rubber

- This process consists of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373 K to 415 K.
- On vulcanisation, sulphur forms cross links at the reactive sites of double bonds and thus the rubber gets stiffened.
- In the manufacture of tyre rubber, 5% of sulphur is used as a crosslinking agent.



Characteristics

1. Resistant against oxidising agents
2. Water holding capacity decreases
3. Stability increases
4. Hardness increases
5. Softness decreases

Polythene

$$n\,CH_2=CH_2 \longrightarrow \{CH_2-CH_2\}_n$$

Low density polythene (LDP)

- Formed by polymerisation of ethene in presence of dioxygen or peroxide initiator at high pressure (1000atm-2000atm) and temperature(350K-570K)
- Formed by free radical addition
- Poor conductor of electricity Chemically inert tough but flexible

Uses –

Manufacture of toys, flexible pipes, squeeze bottles and insulator etc.

2. High density polythene (HDP)

Formed by polymerisation of ethene in presence of Zeigler natta catalyst ($TiCl_4 + Et_3 Al$)at low pressure (6atm-7atm) and temperature (333K-343K)

Chemically inert tough and hard .

Uses –

Manufacture of buckets, dustbin, bottles, pipes etc.

Q. Monomers are converted to polymer by- (AIEEE-2003)

a. Hydrolysis of monomers

b. Condensation reaction between monomers

c. Protonation of monomers

d. None is correct

Q. Nylon threads are made of [AIEEE-2003]

a. A Polyamide polymer

b. Polyethylene polymer

c. Polyvinyl polymer

d. Polyester polymer

Q. Which of the following is a polyamide? [AIEEE-2005]

a. Nylon-66

b. Teflon

c. Bakelite

d. Terylene

Q. Which of the following is fully fluorinated polymer- (AIEEE-2005)

a. Teflon $\{CF_2-CF_2\}_n$

b. Neoprene

c. PVC

d. Buna-s

Q. Bakelite is obtained from phenol by reacting with [AIEEE 2008]

a. CH_3CHO

b. CH_3COCH_3

c. $HCHO$

d. $(CH_2OH)_2$

Q. Among cellulose, poly (vinyl chloride), nylon and natural rubber, the polymer in which the intermolecular force of attraction is weakest is

a. Nylon

b. Poly (vinylchloride)

c. Cellulose

d. Natural Rubber

Q. Which of the following is a natural polymer? *(NEET 2020)*

Natural rubber

a. *cis*-1, 4-polyisoprene

b. poly (Butadiene-styrene)

c. polybutadiene

d. poly (Butadiene-acrylonitrile)

Q. The polymer that is used as a substitute for wool in making commercial fibres is *(Odisha NEET 2019)*

a. melamine

b. nylon-6, 6

c. polyacrylonitrile

d. buna-N

(PAN)

Q. Regarding cross-linked or network polymers, which of the following statements is incorrect? (NEET 2018)

a. They contain covalent bonds between various linear polymer chains.

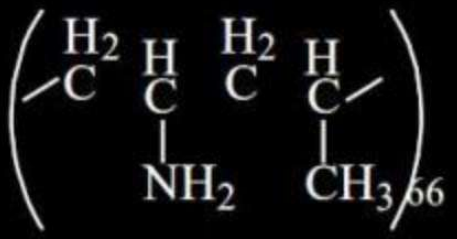
b. They are formed from bi- and tri-functional monomers.

c. Examples are bakelite and melamine.

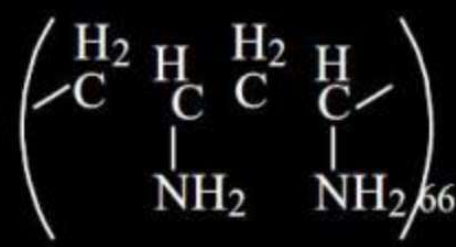
d. They contain strong covalent bonds in their polymer chains.

Q. Which one of the following structures represents nylon 6, 6 polymer?
(NEET-II 2016)

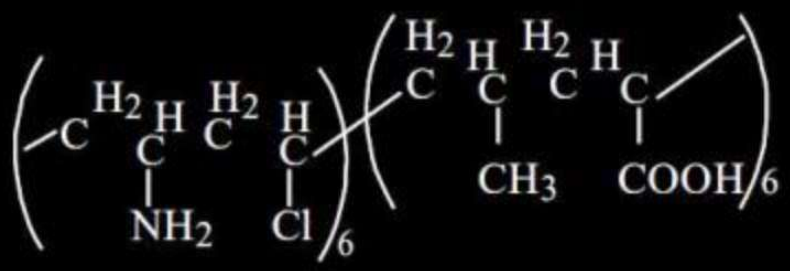
a.



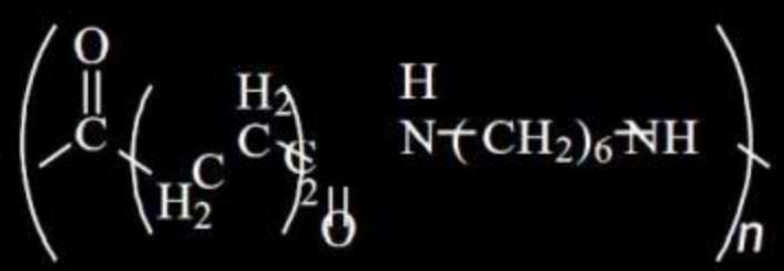
b.



c.



d.



Q. Natural rubber has *(NEET-I 2016)*

a. alternate *cis*- and *trans*-configuration

b. random *cis*- and *trans*-configuration

c. all *cis*-configuration

d. all *trans*-configuration.

Q. Caprolactam is used for the manufacture of (2015)

a. teflon

b. terylene

c. nylon 6, 6

d. nylon 6.

Q. Which of the following organic compounds polymerizes to form the polyester dacron? (2014)

a. Propylene and *para* HO—(C_6H_4)—OH

b. Benzoic acid and ethanol

c. Terephthalic acid and ethylene glycol

d. Benzoic acid and *para* HO—(C_6H_4)—OH

Q. Nylon is an example of (NEET 2013)

a. polyamide

b. polythene

c. polyester

d. polysaccharide

Q. Which is the monomer of neoprene in the following?

a. $CH_2=\underset{\displaystyle Cl}{\overset{|}{C}}-CH=CH_2$

b. $CH_2=CH-C=CH$

c. $CH_2=CH-CH=CH_2$

d. $CH_2=\underset{\displaystyle CH_3}{\overset{|}{C}}-CH=CH_2$

$CH\equiv C-CH=CH_2$

$\downarrow HCl$

$CH_2=\underset{\displaystyle Cl}{\overset{|}{C}}H-CH=CH_2$

Q. Which one of the following is not a condensation polymer? (2012)

a. Melamine

b. Glyptal

c. Dacron

d. Neoprene

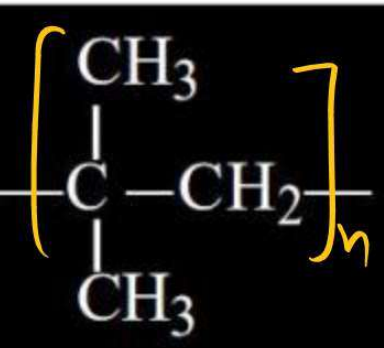
Q. Which of the following statements is false? (2012)

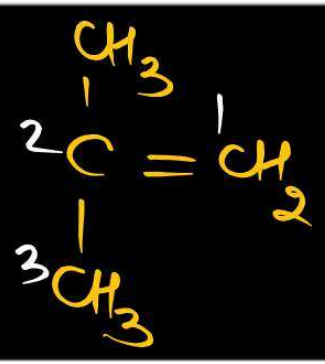
a. Artificial silk is derived from cellulose

b. Nylon-6,6 is an example of elastomer. (Fibre)

c. The repeat unit in natural rubber is isoprene.

d. Both starch and cellulose are polymers of glucose.

Q. Monomer of  is



(2002)

a. 2-methylpropene

b. styrene

c. propylene

d. ethene.

Q. $CF_2 = CF_2$ (TFE) is monomer of (2002)

a. Teflon (PTFE)

b. styrene

c. orlon

d. nylon-6

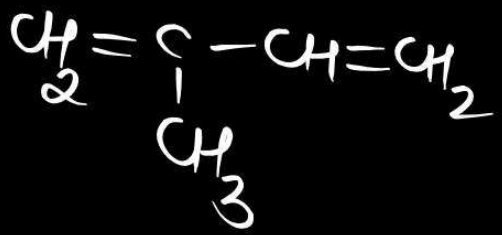
Q. Natural rubber is a polymer of (1999)

a. styrene

b. ethyne

c. butadiene

d. isoprene



उम्मEE

Q. Terylene is a condensation polymer of ethylene glycol and *(1999)*

a. salicylic acid

b. phthalic acid

c. benzoic acid

d. terephthalic acid

Q. Which one of the following is used to make 'non- stick' cookware? *(1997)*

a. Polyethylene terephthalate

b. Polytetrafluoroethylene

c. PVC

d. Polystyrene

Teflon

$+[CF_2-CF_2]_n$

Q. The bakelite is prepared by the reaction between (1995)

a. phenol and formaldehyde

b. tetramethylene glycol

c. urea and formaldehyde

d. ethylene glycol

Q. The biodegradable polymer is *(NEET 2019)*

a. buna-S

b. nylon-6,6

c. nylon-2-nylon 6

d. nylon-6

Glycine + amino caproic acid

Q. The biodegradable polymer is *(Main 2019)*

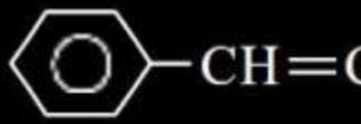
Buna-N

a. $CH_2=CH-CN$ and $CH_2=CH-CH=CH_2$

b. H_2N-CH_2-COOH and $H_2N-(CH_2)_5-COOH$

c. $HO-CH_2-CH_2-OH$ and

Dacron

d.  and $CH_2=CH-CH=CH_2$

Buna-S