

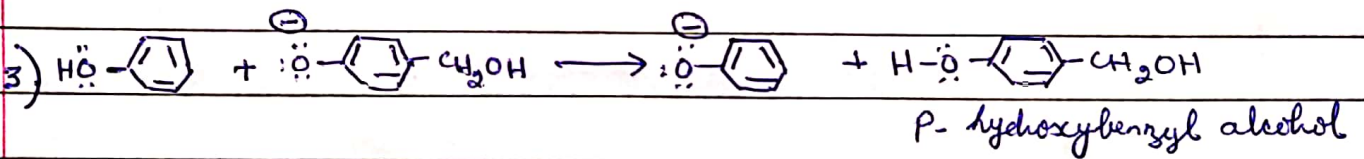
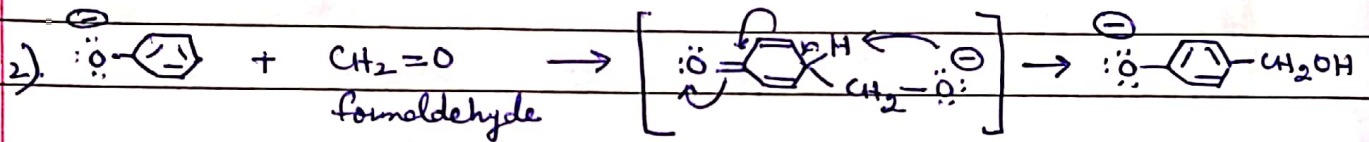
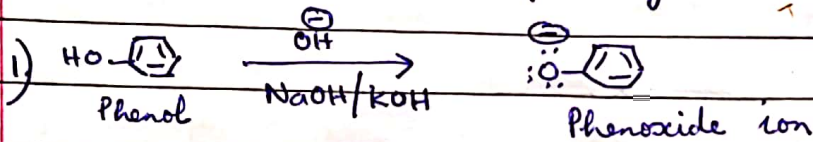
# Polymers

## Preparation and applications of plastics

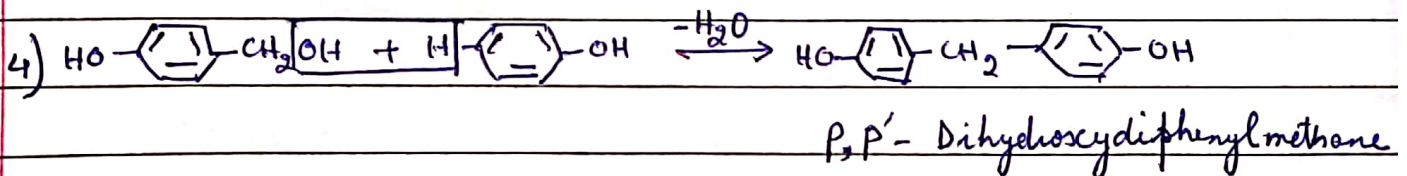
### A. Thermosetting Plastics

i) Phenol-formaldehyde resins: They represent an important class of polymers produced by reaction between phenols and formaldehyde in presence of basic catalyst. The polymer formed may be the low molecular weight branched polymer Novolac or the high molecular weight cross-linked thermosetting resin Bakelite depending upon the experimental conditions.

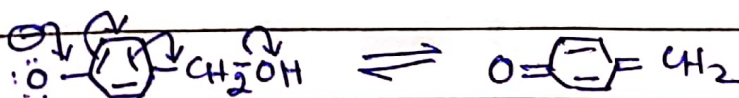
Mechanism: This polycondensation reaction proceeds by the following mechanistic pathway:

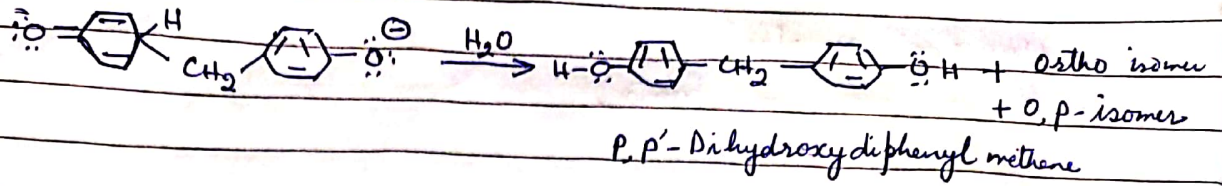
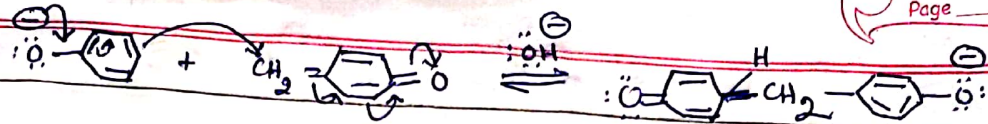


This nucleophilic addition can take place at the ortho position also.

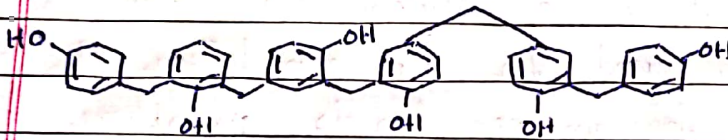


This step is believed to proceed as shown:

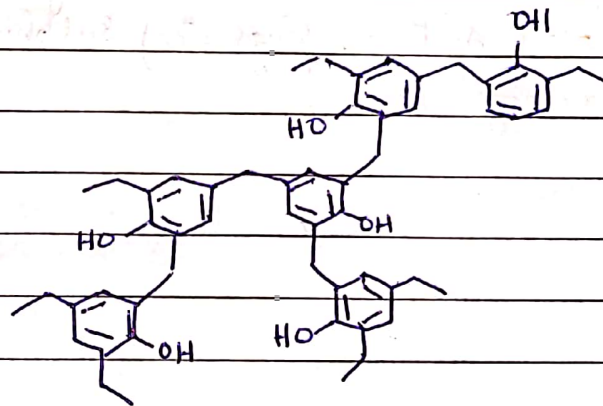




The above reactions are continued to produce polymers in which all the available ortho and para positions of the phenol may be occupied. Depending on the experimental conditions, these polymers can have non-cross linked or a cross-linked three dimensional structures as shown below:

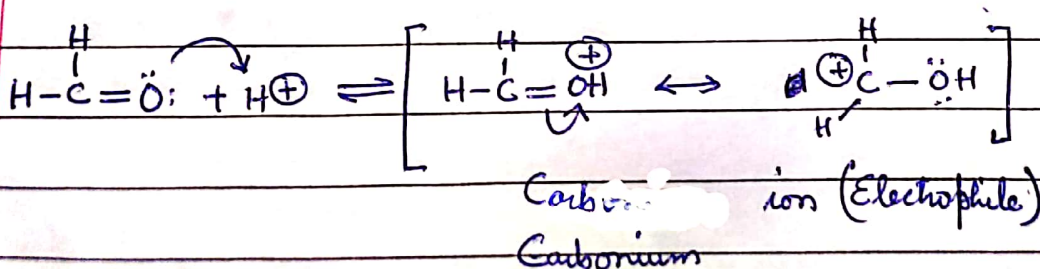


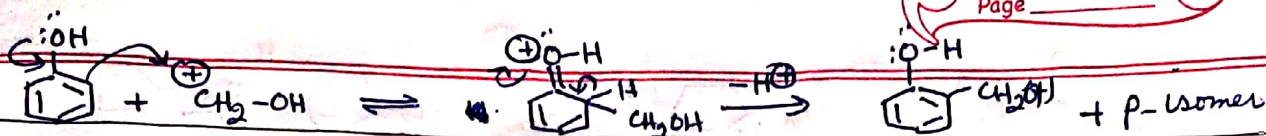
Phenol-formaldehyde resin [non cross linked, (Novolac)]



Phenol-formaldehyde resin [cross-linked, Bakelite]

Phenol-formaldehyde resins can be produced by acid catalysed reactions also. The first step of acid catalysed reaction is shown below:





### Uses of Novolac :

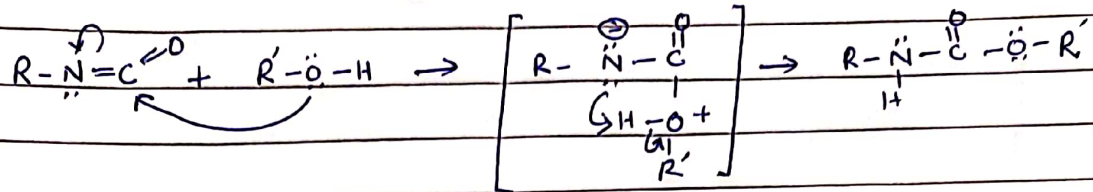
1. It is used in paints

### Uses of Bakelite :

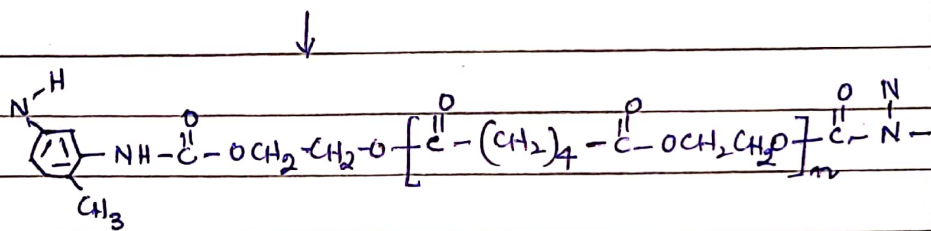
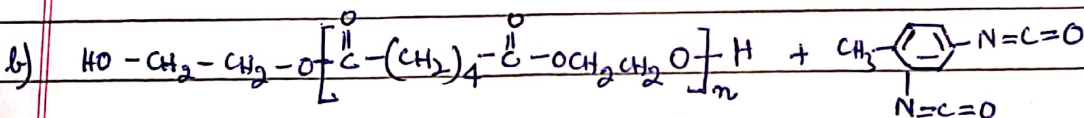
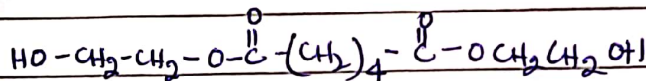
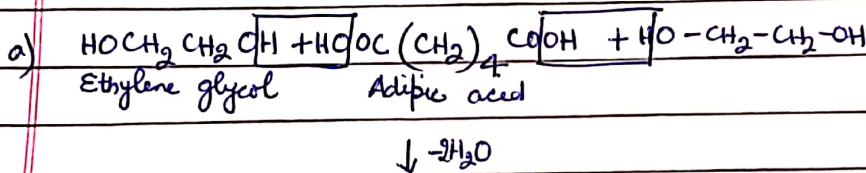
Soft bakelites with low degree of polymerisation are used as binding glue for laminated wooden planks, and in varnishes and lacquers. High degree polymerisation leads to the formation of a hard bakelite which is highly cross-linked and is thermosetting polymer. It is a scratch and water-resistant polymer and hence is used for the manufacture of combs, formica table-tops, fountain pen barrels, gramophone records, etc. It also possesses excellent electrical insulating properties and hence widely used in making electrical goods (switches, plugs etc). Sulphonated bakelites are used as ion exchange resins.

— X —

**Polyurethanes** : They are obtained by the treatment of di-isocyanates with alcohols. It is known that compounds containing active hydrogen (say, alcohols) add across the N=C double bond of isocyanates to form urethanes.



This is the basic reaction involved in the formation of polyurethanes. The di-isocyanate generally used in polyurethane is a  $\phi$  toluene 2,4-di-isocyanate, and the alcohol commonly used is a pre-polymer containing -OH as the end groups, as illustrated below:



Polyurethane

**Uses** : Polyurethanes are resistant to alkaline or acid hydrolysis. They have been processed into fibres and films. The most important use of polyurethanes has been in the development of foams. These polyurethane foams have been used for household and office furnitures and automobile cushioning.

By using suitable monomer units, adhesive, lacquers and paints have also been produced.