UNIT

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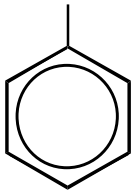
PHENOL

11. Phenol

New NEB Syllabus

- Introduction & nomenclature phenol
- Preparation of phenol from
  - Chlorobenzene
  - Diazonium salt and
  - Benzene sulphonic acid
- Physical properties of phenol
- Chemical properties
  - Acidic nature of phenol (comparison with alcohol & water)
  - Action with NH_3, Zn, Na, benzene diazonium chloride and phthalic anhydride
  - Acylation reaction, Kolbe's reaction, Reimer Tiemann's reaction
  - Electrophilic substitution reaction:
    - ✓ Halogenation (Bromination)
    - ✓ Nitration
    - ✓ Sulphonation and
    - ✓ Friedel Craft's alkylation
  - Laboratory test of phenol ($FeCl_3$ test, aq. Br_2 test & Libermann test)
- Uses of phenol

NOTES AAYO

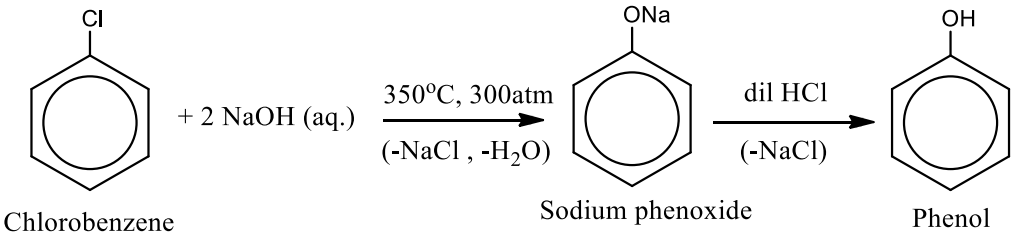


Phenol
(Hydroxy benzene)

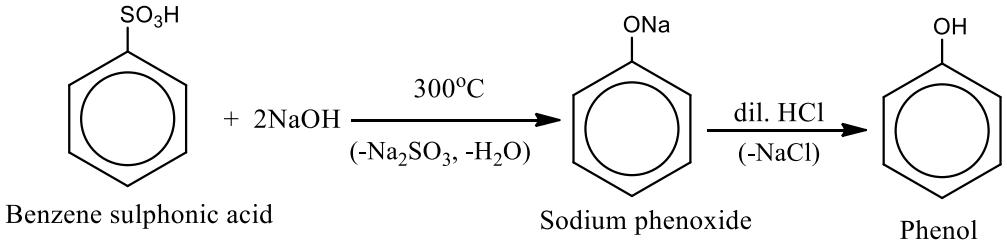
Phenols are hydroxyl derivatives of aromatic hydrocarbon in which hydroxyl group (- OH) is directly attached to an aromatic ring. It is also known as Carbolic acid.
General formula: Ar - OH
Molecular formula: C_6H_5OH

General Method of Preparation

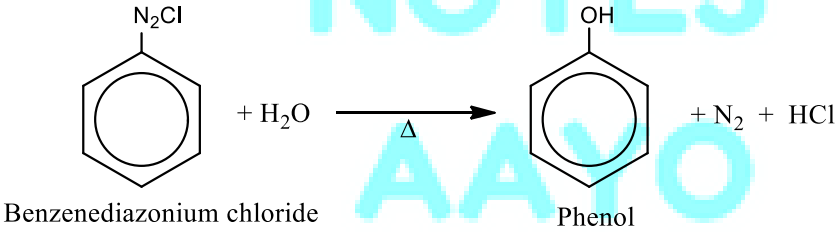
1.From Chlorobenzene (*Dow's process*)



2. From benzene sulphonic acid



3. From benzenediazonium chloride

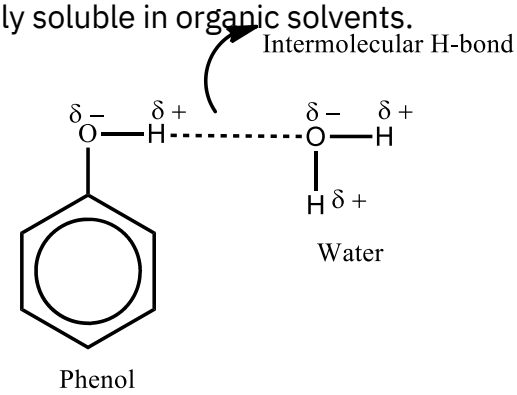


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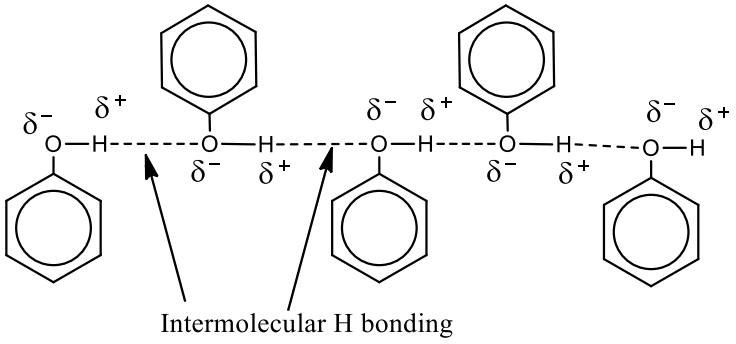
Physical Properties:

1. State, color and odour:
   Phenols are colorless low melting crystalline solid or liquid with characteristics odour (Carbolic or disinfectant like smell) but turn into pink/reddish color due to slow oxidation in with air.

2. Solubility:
   Phenols are sparingly soluble in water due to its ability to form *intermolecular hydrogen bond* with water molecule. It is readily soluble in organic solvents.



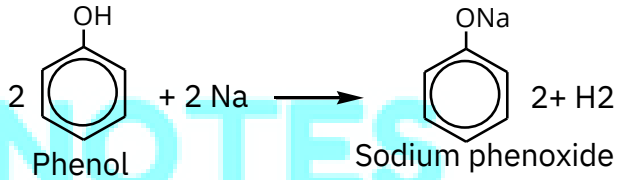
3. Boiling point:
   Phenols have higher boiling point than corresponding aromatic hydrocarbon of comparable molecular mass this is due to the existence of intermolecular hydrogen bonding in phenols.



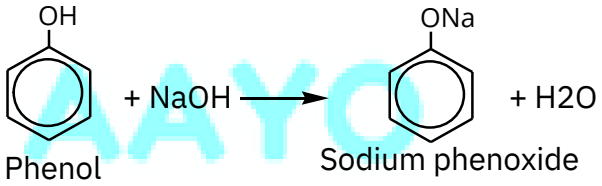
Chemical Properties:

1. Acidic nature:
   Phenols are weaker acid, turn blue litmus into red, give H2 gas with active metals, neutralizes strong alkalies to give salt and water.

   i. Reaction with Na



   ii. Reaction with NaOH



   Phenols are stronger acid than alcohol and water bur weaker acid than carboxylic acids because phenol ca
   decompose carbonates or bicarbonates to give CO2 gas.

   Why phenols are more acidic than alcohols?

   a) Effect of aryl group on acidic strength of phenol

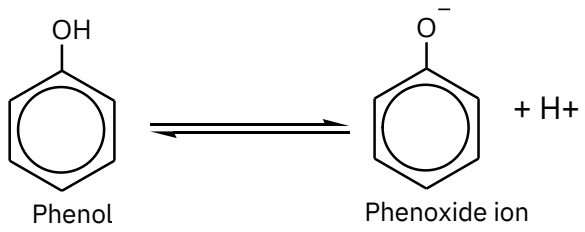


   PhenolAlcohol

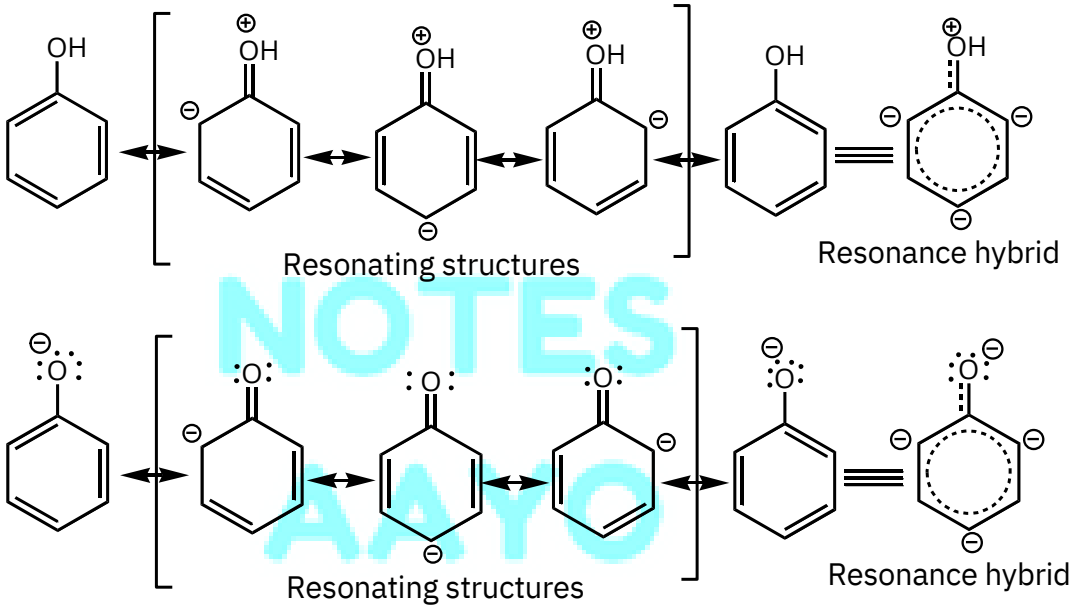
   In phenol benzene ring is electron withdrawing group, so it decreases electron density at oxygen atom. As a result, oxygen atom shows greater tendency to pull shared electrons towards itself. This increases the polarity of O – H bond. Therefore breaking of O – H bond becomes more easily i.e. more acidic.
   In alcohol alkyl group is electron donating group which decreases the polarity of O – H bond. Therefore, breaking of O – H bond becomes difficult i.e., weaker acid.

b) Effect of resonance on acidic strength of phenol.

Phenol & phenoxide are stabilized by resonance but phenoxide ion is found to be more stable than phenol because there is no charge separation in resonating structures of phenoxide ion. Therefore the equilibrium shift to the right to produce more stable phenoxide ion and H+ ion (or hydronium ion H3O+)

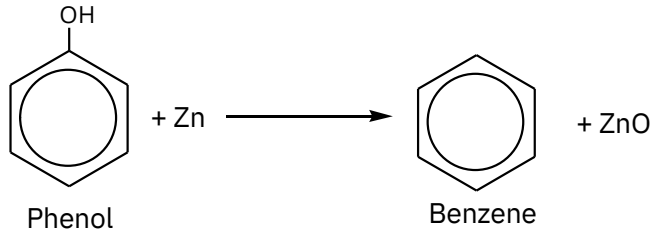


Both phenol and phenoxide ion are stabilized by resonance.

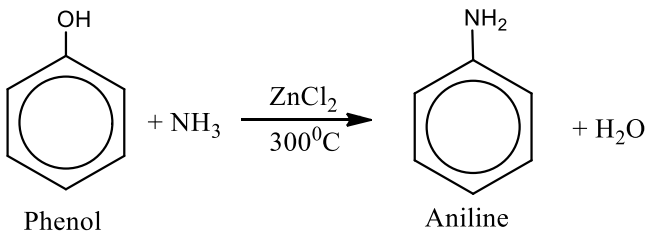


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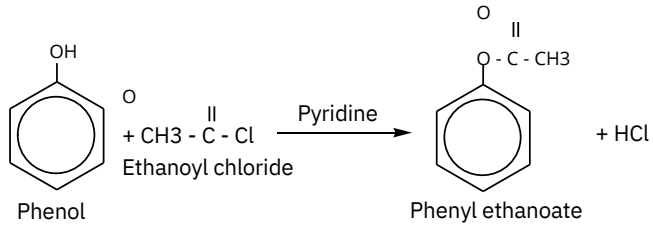
2. Reaction with Zn

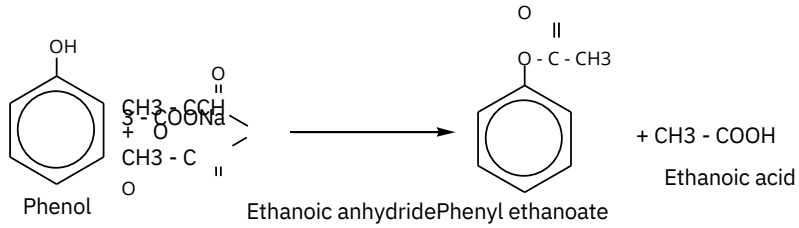


3. Reaction with NH3

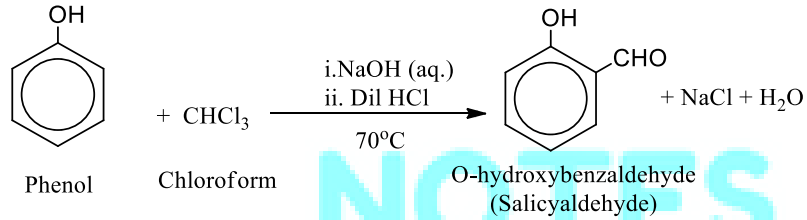


4. Acylation reaction



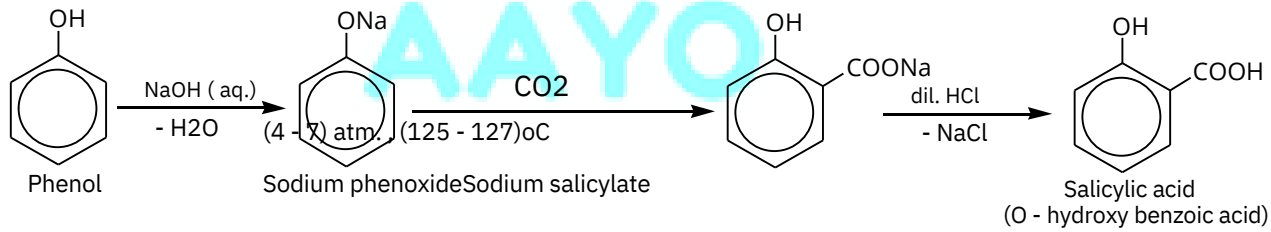


5. Reimer Tiemann's reaction



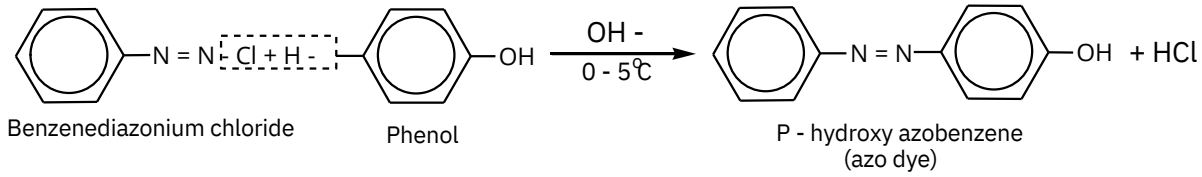
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6. Kolbe's reaction (Carboxylation reaction)

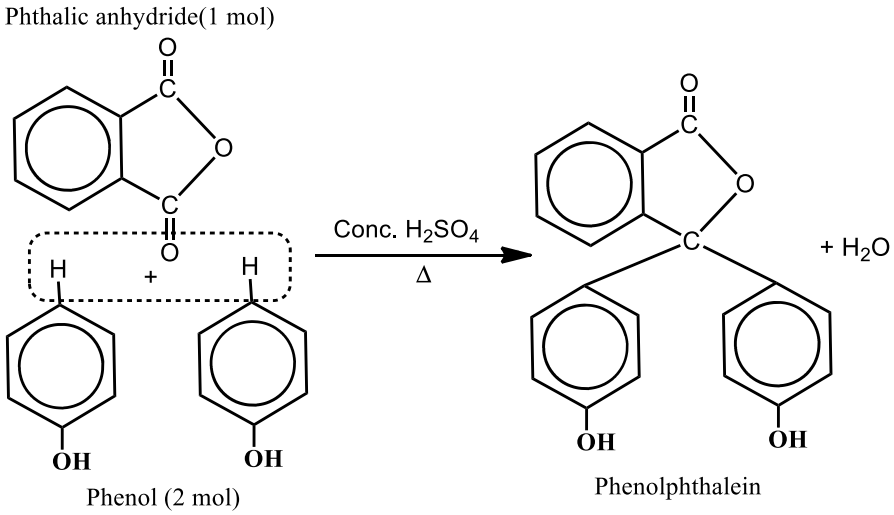


AAYO

7. Coupling reaction: (Reaction with Benzenediazonium chloride)

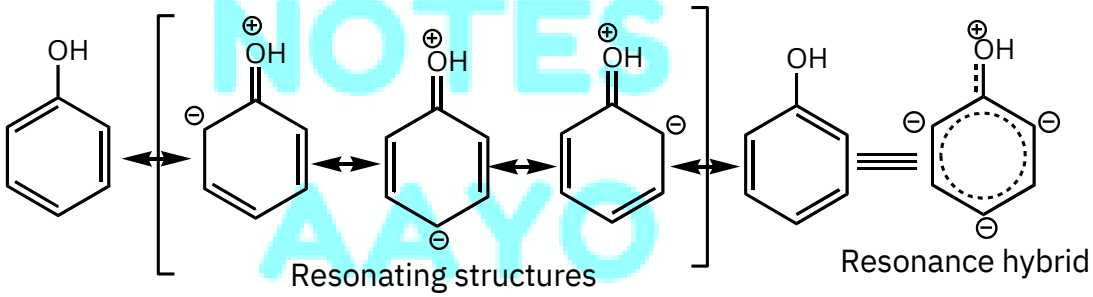


8. Reaction with phthalic anhydride



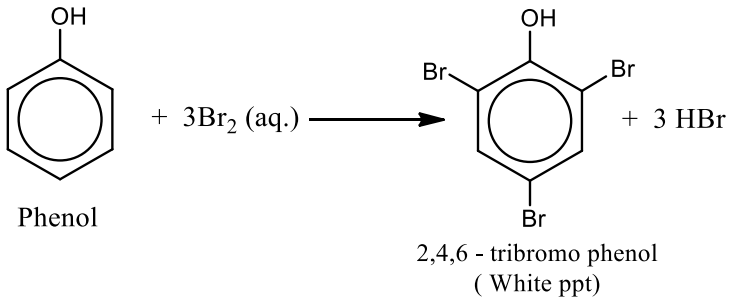
9.Electrophilic substitution reaction

Phenol undergoes electrophilic substitution reactions much easily than benzene. In phenol –OH group is activating group, increases the electron density at ortho and para position, thus – OH group is the ortho and para director.

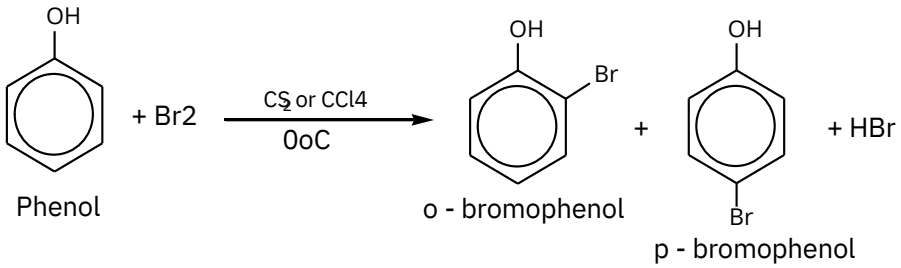


a) Halogenation:

Phenols give poly halogen substituted compounds when treated with aq. Br2.

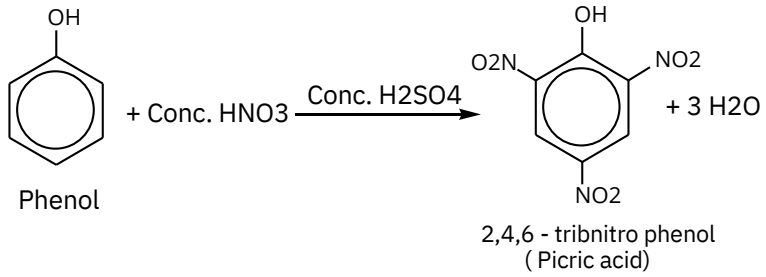


NOTE: If less polar solvent like CS2 or CCl4 are used at low temperature, ortho and para substituted products are formed.



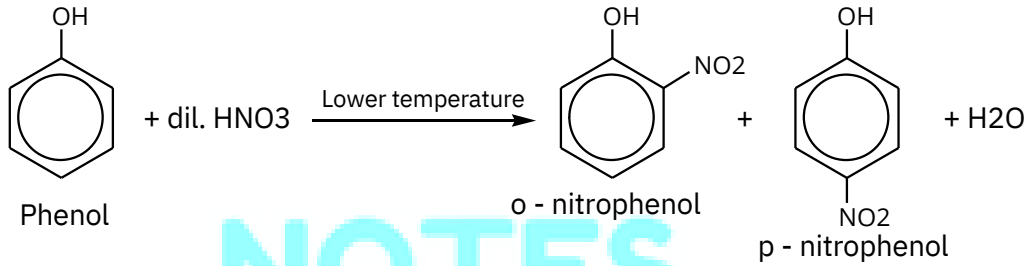
b)Nitration:

When phenol is treated with conc. HNO3 in presence of conc. H2SO4, 2,4,6 –trinitrophenol is formed.



Uses of Picric acid: used as explosive, dyes

If phenol is treated with dil HNO3 at low temperature, ortho and para substituted phenol are formed.

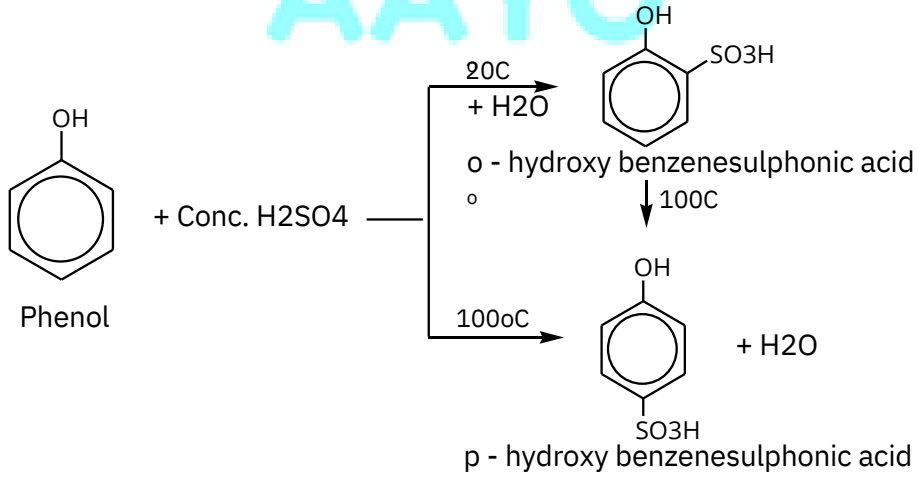


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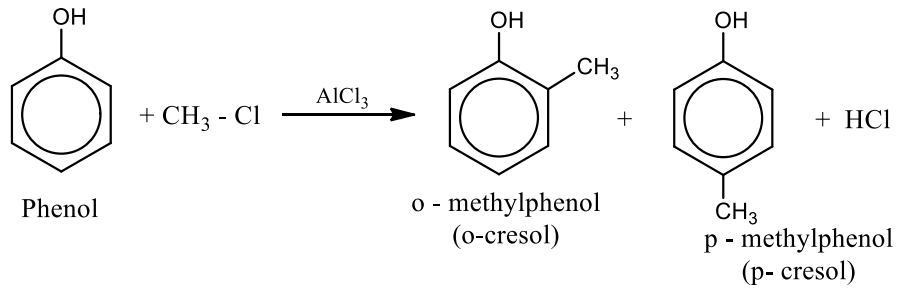
c) Sulphonation:

When phenol is treated with conc. H2SO4, ortho and para substituted product are formed at low and high temperature respectively.

AAYO



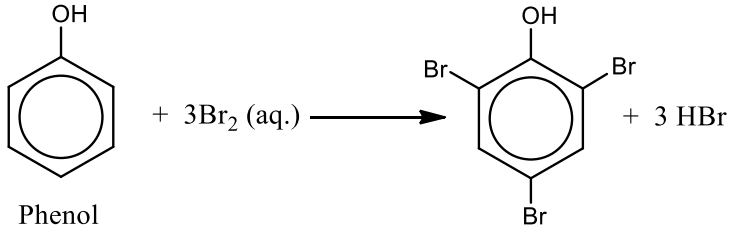
d) Friedel – Craft alkylation



Laboratory Test of Phenol

1. Aq. Br2 test

When phenol is tested with few drops of aqueous bromine then white ppt is formed.

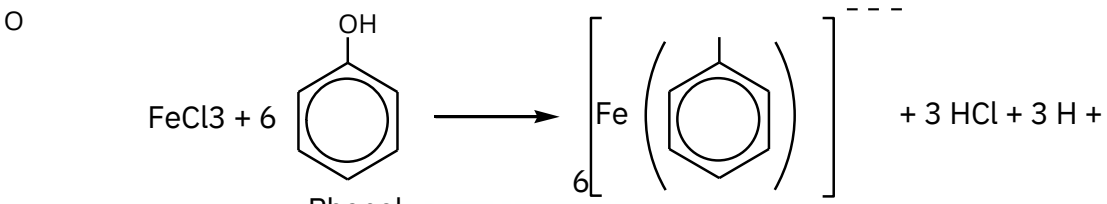


Phenol

2,4,6 - tribromo phenol
(White ppt)

2. FeCl3 Test

When phenol is tested with few drops of aqueous ferric chloride solution then violet colour is obtained.

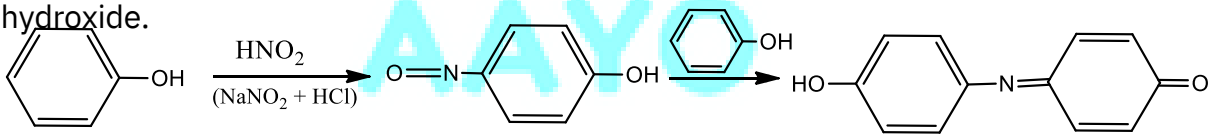


Phenol

Iron hexa phenoxide ion
(Violet color)

3. Libermann's test

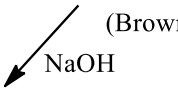
When phenol is treated with nitrous acid followed by addition of excess phenol, brown indophenol is formed which produce blue colour after treatment with alkali like sodium hydroxide.

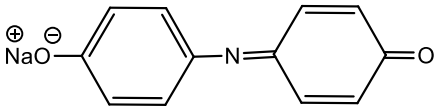


Phenol

p- nitrosophenol

Indophenol
(Brown solid , red in alcohol)





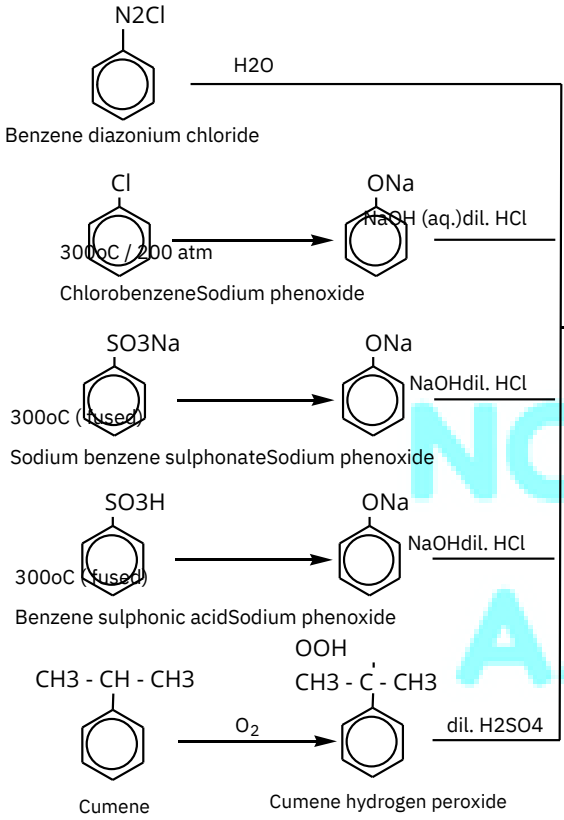
sodium salt of Indophenol
(blue solution)

Uses:

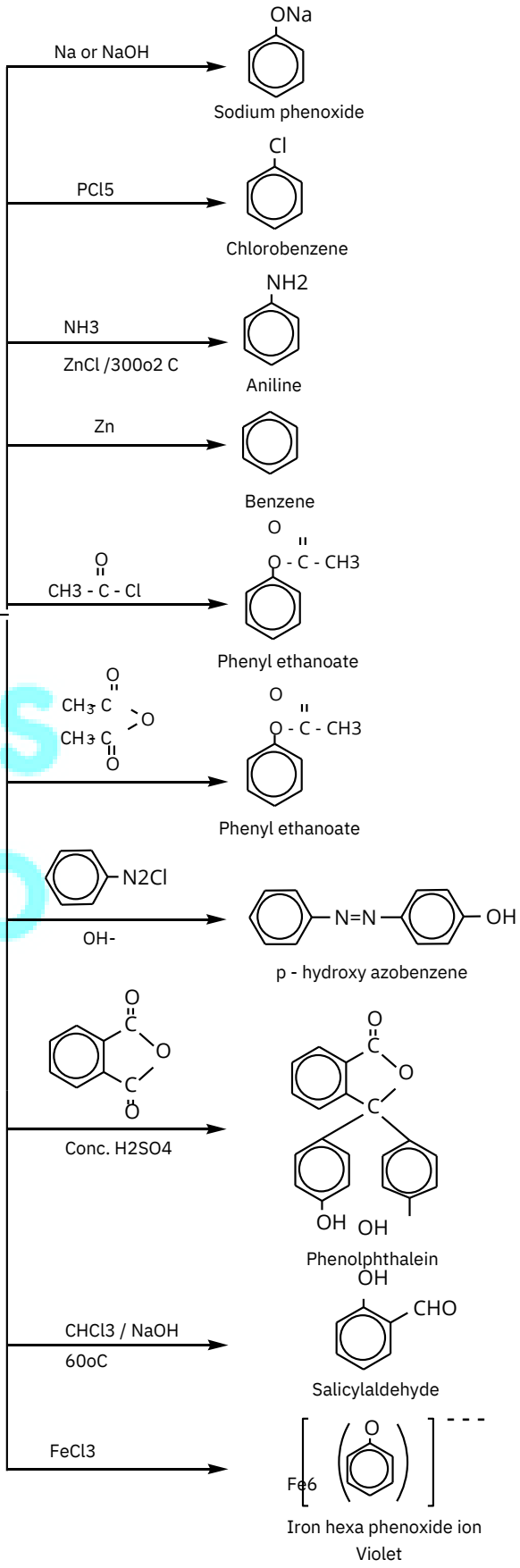
- ✓ *In the manufacture of dyes , drugs, explosives etc*
- ✓ *In the manufacture of Bakelite*
- ✓ *In the preparation of picric acid and phenolphthalein as an antiseptic and disinfectant*

✓

Methods of Preparation

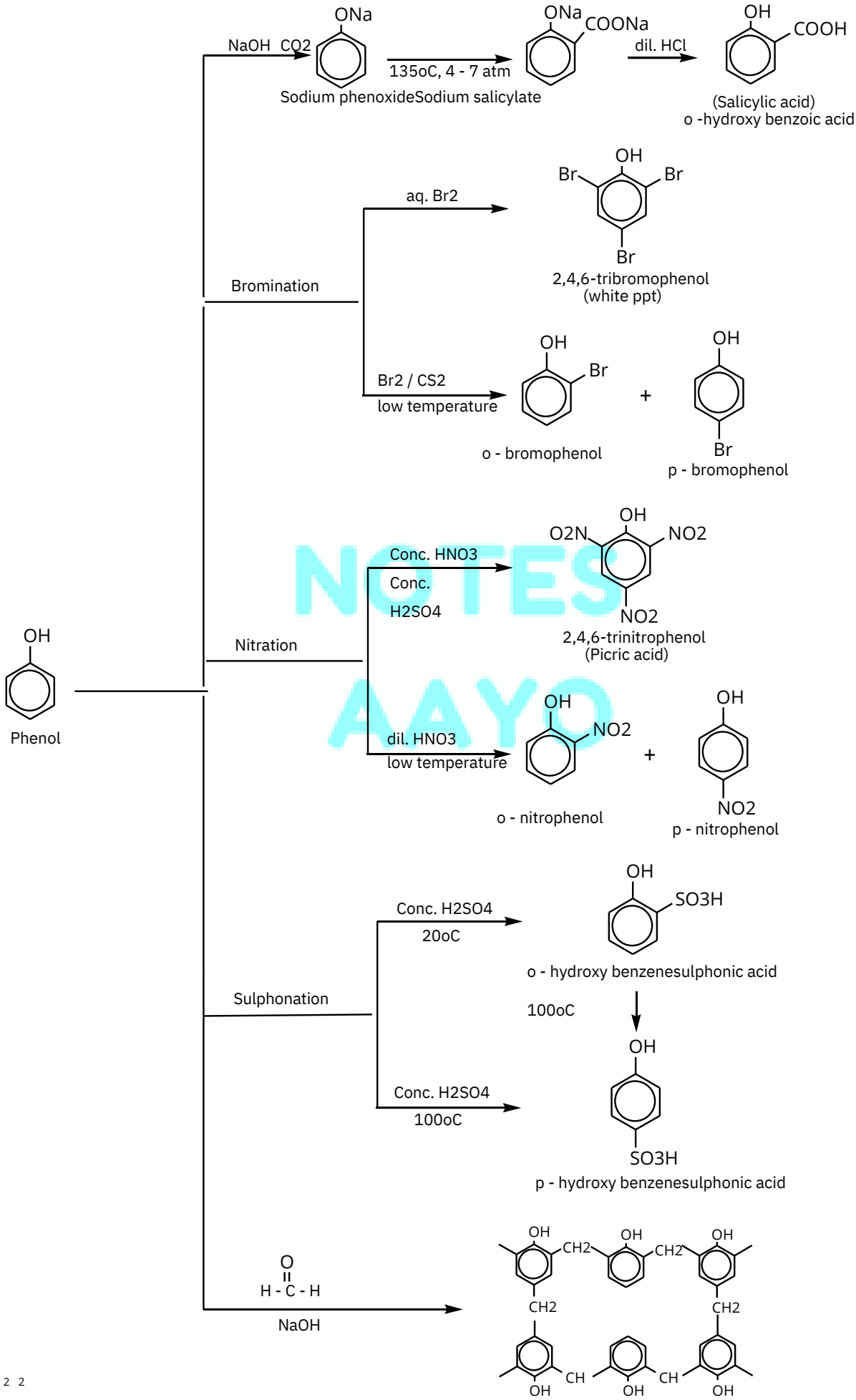


Chemical Properties



NOTES AAYO

Chemical Properties



NOTES AAYO

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