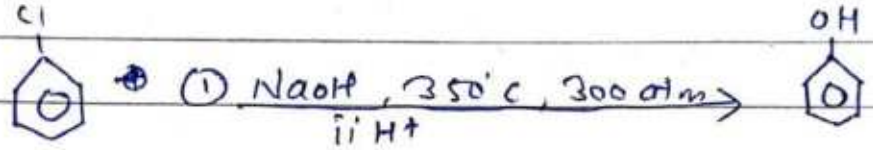
Unit:- phenol

phenol:-  or C_6H_5OH

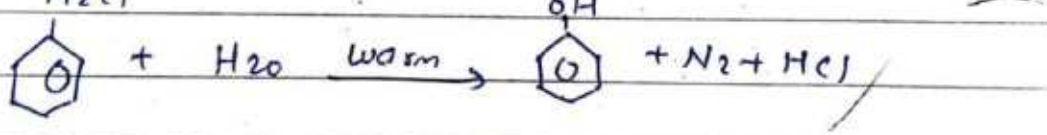
→ The organic compound in which hydroxy group is directly attached to carbon atom of benzene ring (aromatic ring) is called phenol.

* General method of preparation:-

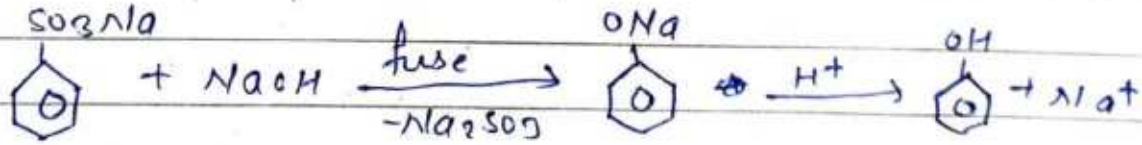
(i) From haloarene:-



(ii) From benzenediazonium chloride.



(iii) From Sodium benzene sulphonate.

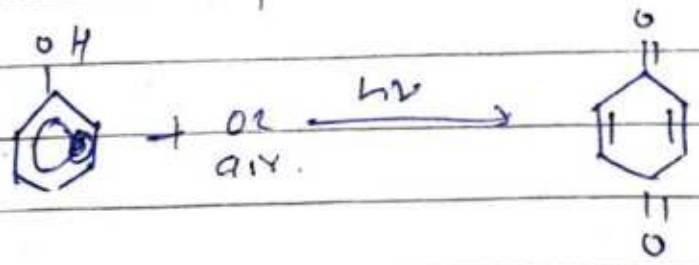


* physical properties of phenol.

(i) physical state:-

phenol is colourless liquid with characteristics phenolic ~~acid~~ smell But some time

pink or yellow colour appears due to slow oxidation of phenol in air, in presence of light.



p - Benzoquinone.

(ii) Boiling point :-

phenol has high boiling point than other aeromatic hydrocarbon like toluene, haloarene having comparable molecular mass because phenol can form intermolecular hydrogen bond but other can't form intermolecular hydrogen bond.

(iii) Solubility :-

phenol is sparingly (slight) soluble in water though it can form inter molecular hydrogen bond with water. It is because bulky phenyl group present in phenol shows strong hydrophobic interaction

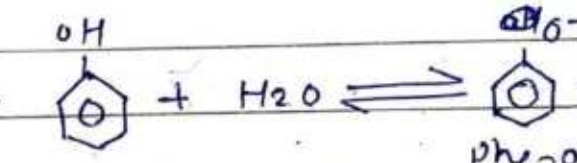
* Chemical properties of phenol

① Acidic Nature :-

phenol is acidic in nature because it can release H^+ ion in water and the phenoxide ion produced is stabilised by resonance.

phenol is more acidic than aliphatic alcohol because the phenoxide ion produced after release of H^+ ion from phenol is stablised by resonance but such stability is not possible for alkoxide ion produced by release of H^+ from aliphatic alcohol

Dissociation:



phenoxide ion

Stabilization:

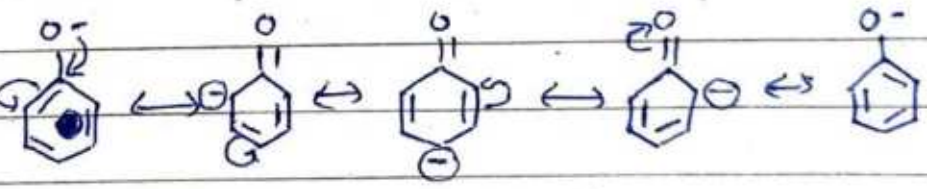
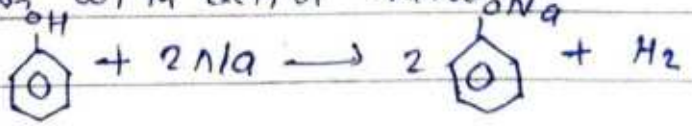
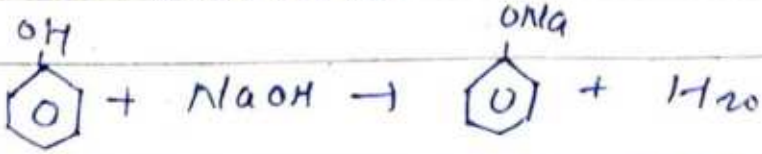


Fig:- Resonance str. phenoxide ion.

Rxn. Reaction with active metal

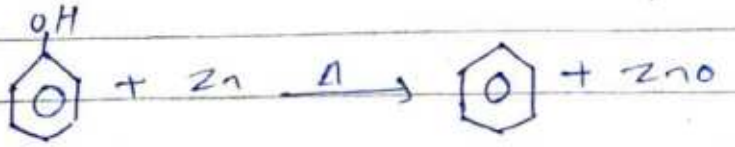


② Reaction with alkali

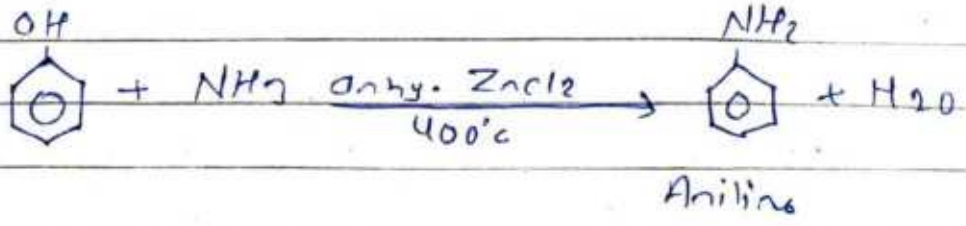


$ZnCl_2 + HCl_{(g)}$

② Reaction with zinc dust:-



② Reaction with ammonia



Aniline

④ Reaction with $FeCl_3$:-

When ferric chloride solution is added to phenol, violet coloured water soluble complex compound is formed. This reaction is used as test reaction for phenol

$$6\,C_6H_5OH + FeCl_{3(aq.)} \longrightarrow \underset{\text{violet}}{[Fe(C_6H_5O)_6]^{3-}} + \underset{3HCl}{3H^+}$$

(ferric hexaphenoxide ion)

⑤ Electrophilic substitution Rxn:-

In phenol electrophilic substitution reaction takes place at ortho and para position. because resonance caused by Hydroxy group increase electron density at ortho and para position. So, Hydroxy group in

phenol is called ortho - para directing group.

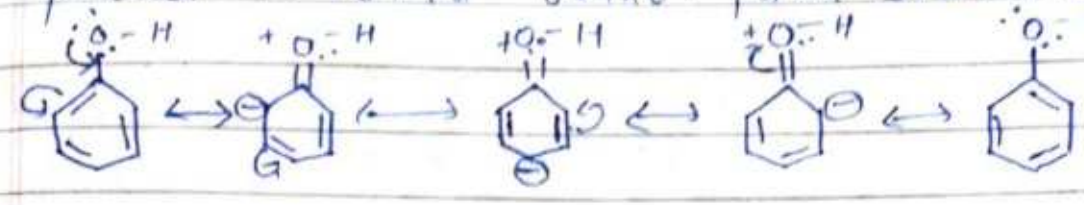
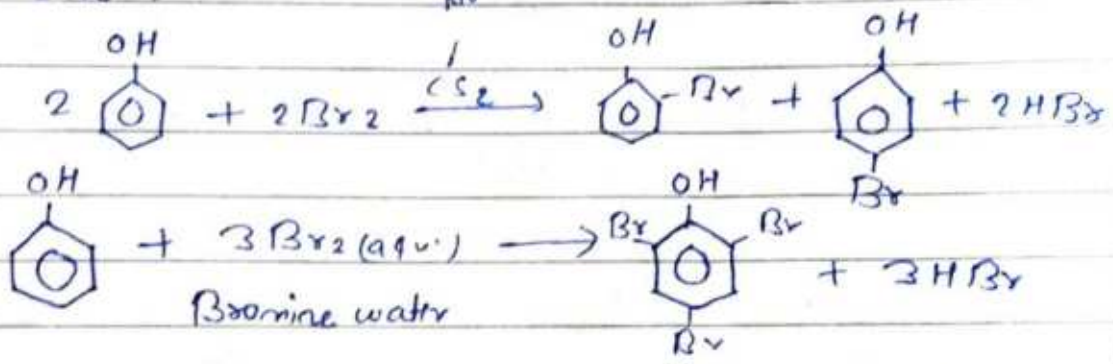
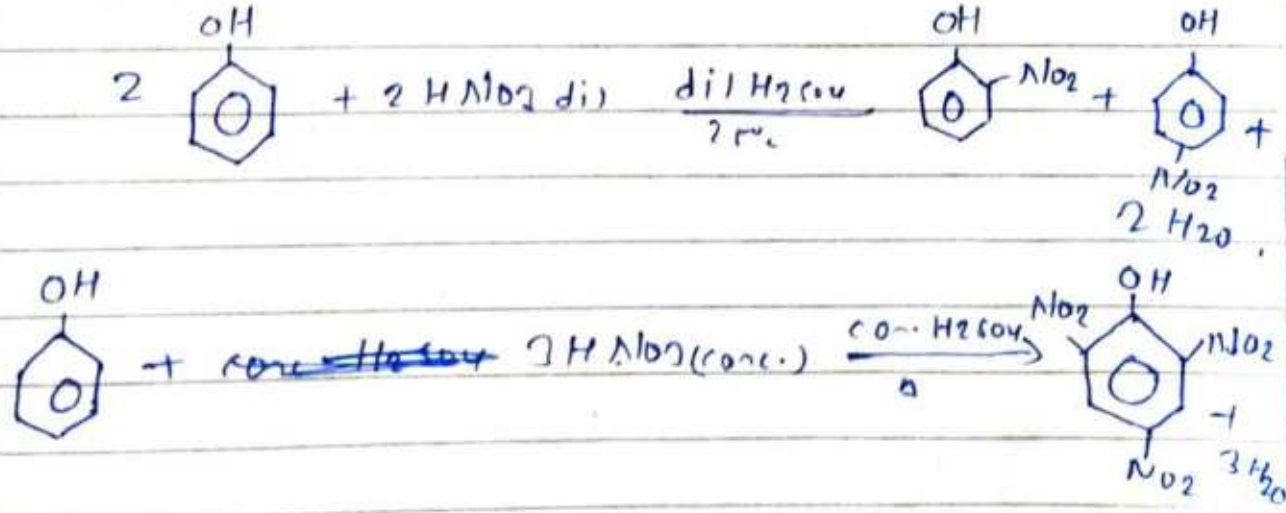


Fig Resonance str. of phenol

① Halogenation:-

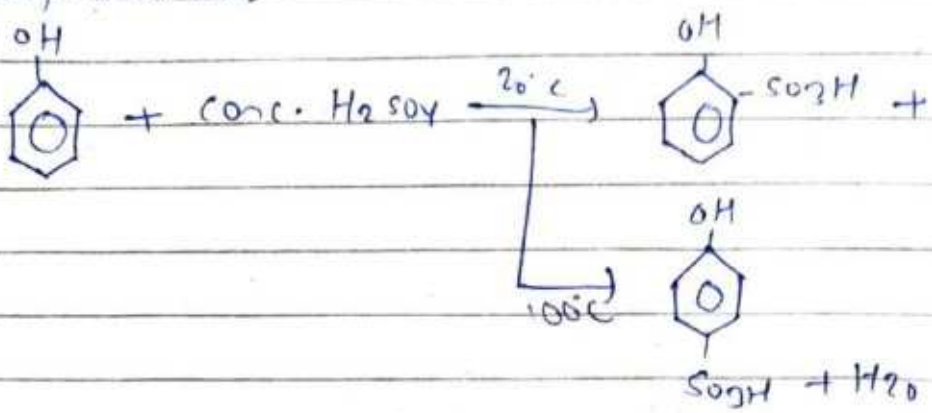


② Nitration:-



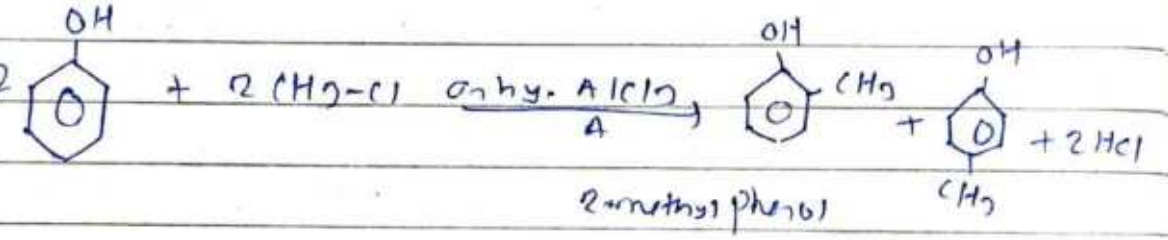
$CH_3-\overset{\overset{O}{\|}}{C}-COOH$

(iii) Sulphonation:-



p-hydroxybenzene sulphonic acid.

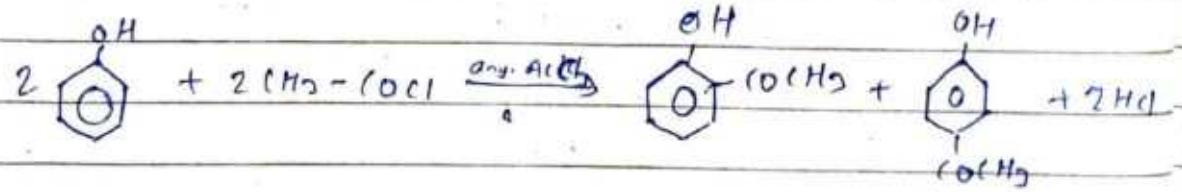
(iv) Friedal craft alkylation:-



2-methyl phenol

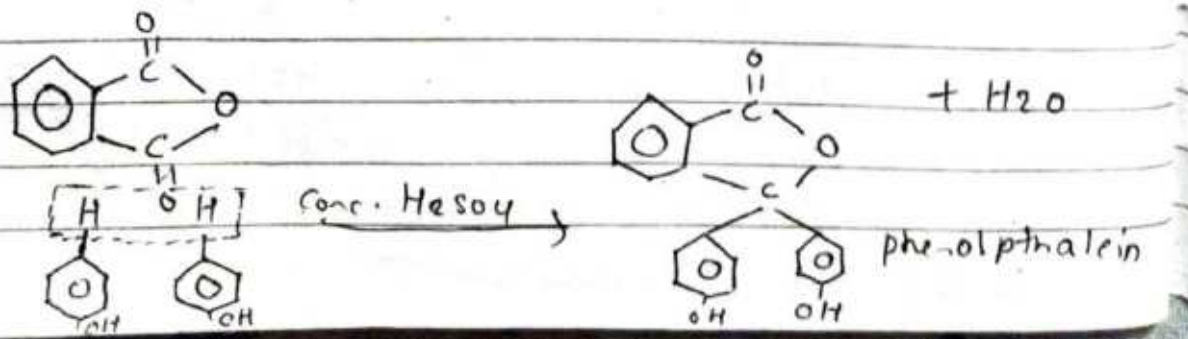
p-methyphenol

(v) Friedal craft acylation:-



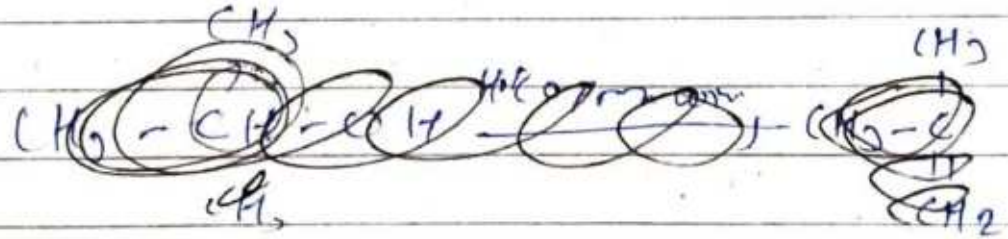
p-hydroxy acetophenone

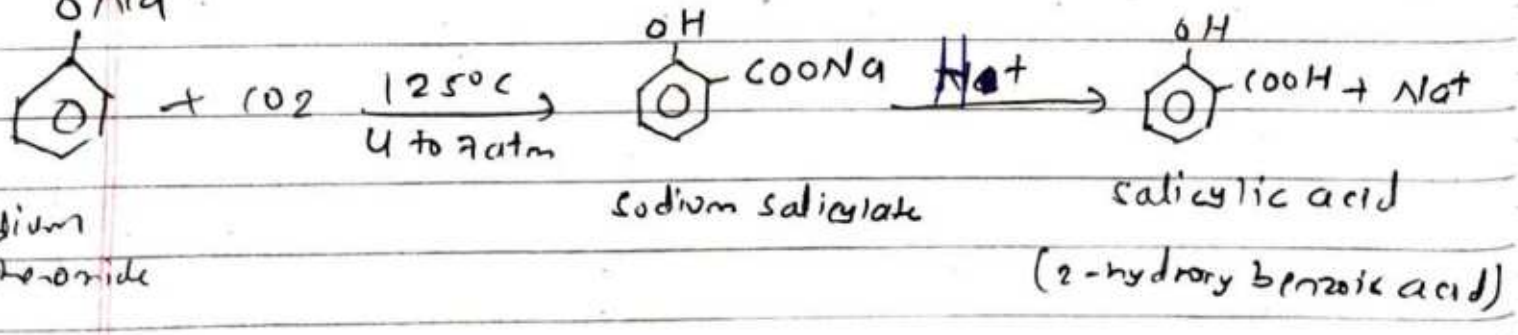
(vi) Reaction with phthalic anhydride:-



(2) Kobie's reaction

When sodium phenoxide is treated with carbon dioxide at 125°C temperature and 4 to 7 atm pressure, it undergoes carbonylation reaction producing sodium salicylate which on acidification give salicylic acid. This reaction is called Kobie's reaction





Sodium phenoxide

Sodium salicylate

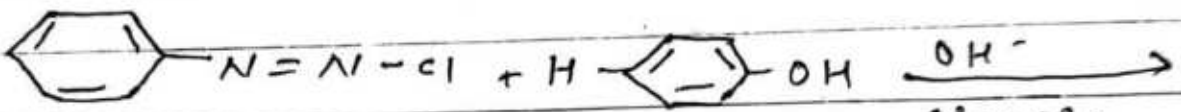
Salicylic acid

(2-hydroxy benzoic acid)

⑧ coupling:-

The reaction during which two benzene ring join together through the group like azo (-N=N-) group is called coupling reaction.

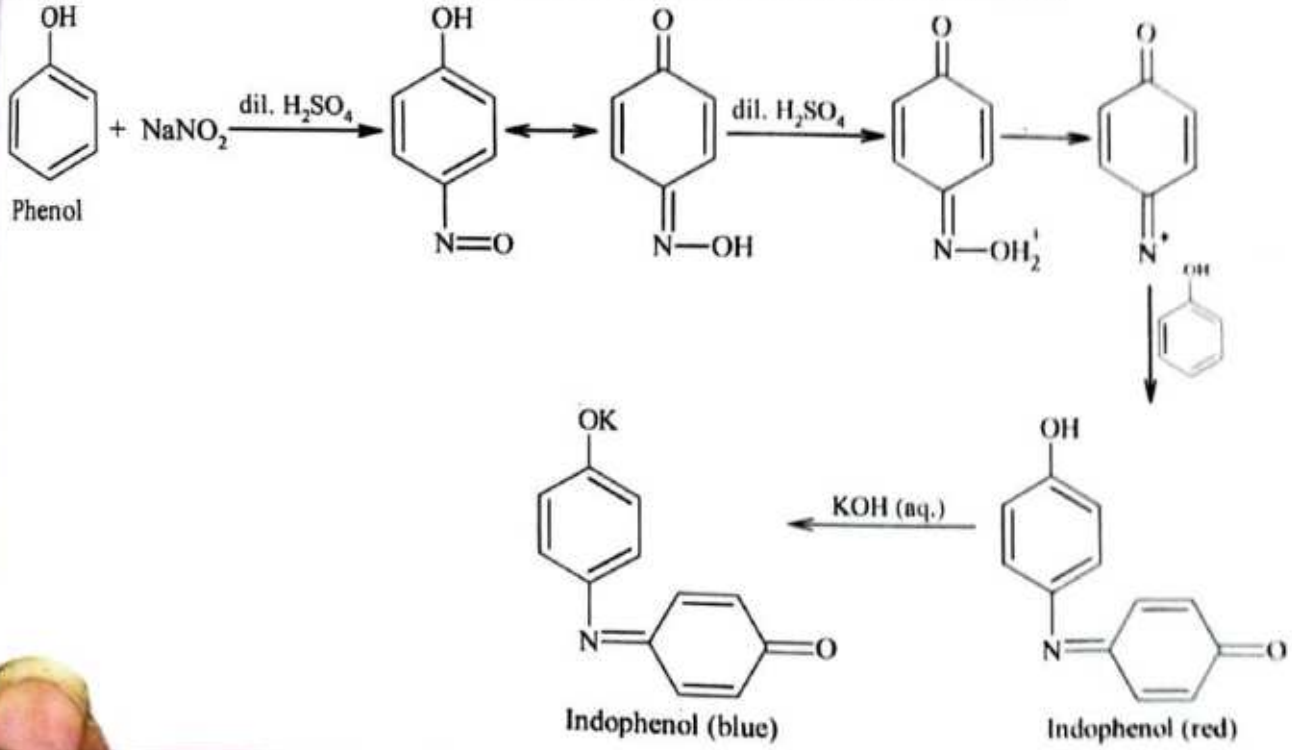
When phenol is treated with benzene diazonium chloride at 0°c to 5°c temperature at slightly alkaline medium, it gives p-hydroxy azo benzene



2,4,6-tribromophenol

Libermann's Nitroso Test

When phenol is reacted with $NaNO_2$ and dil. H_2SO_4, it provides a deep green or blue colour which changes to red on dilution with water. Generated substance in presence of KOH restores original green or blue colour. This reaction is termed as Liebermann's nitroso reaction.



Explain why phenol is ortho and para director in electrophilic aromatic substitution reaction?