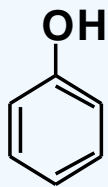


Phenols

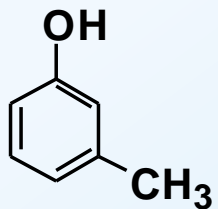
Dr. Sapna Gupta

Nomenclature

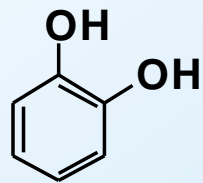
- Benzene with one OH group (alcohol) – phenol



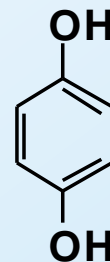
Phenol



3-Methylphenol
(m- Cresol)



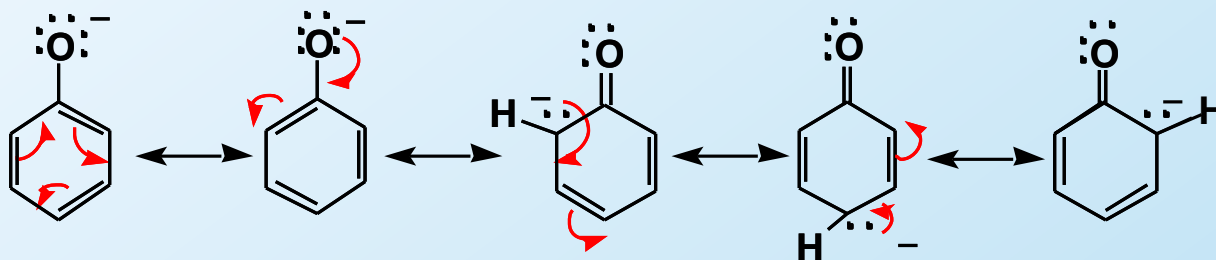
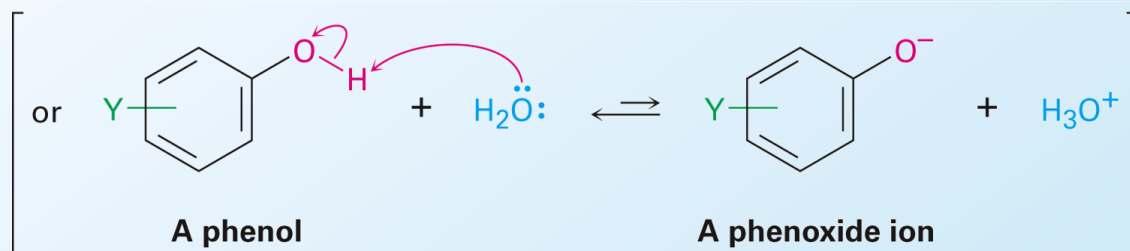
1,2-Benzenediol
(Catechol)



1,4-Benzenediol
(Hydroquinone)

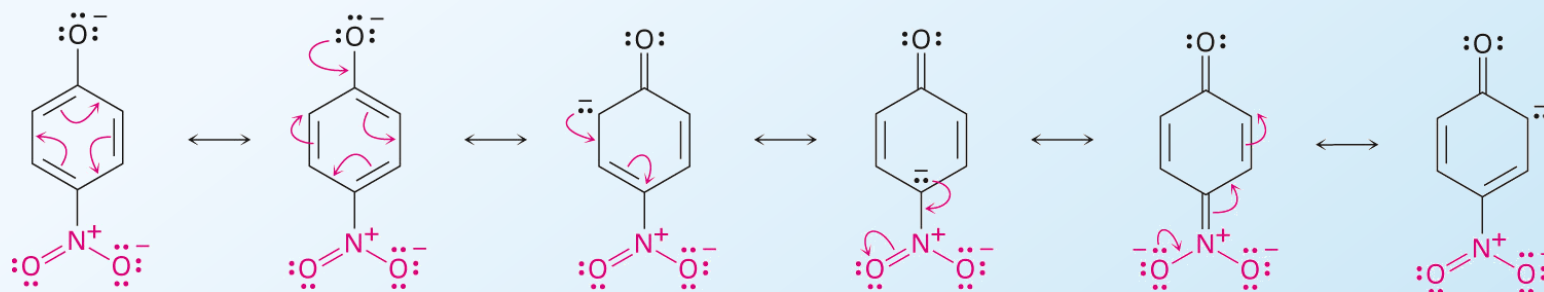
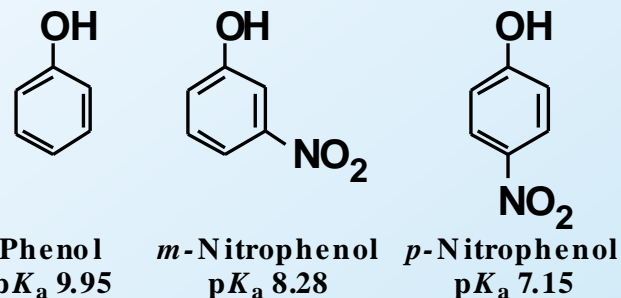
Acidity of Phenols

- Phenols ($pK_a \sim 10$) are much more acidic than alcohols ($pK_a \sim 16$) because of resonance stabilization of the phenoxide ion
- Phenols react with NaOH solutions (but alcohols do not), forming salts that are soluble in dilute aqueous solution
- A phenolic component can be separated from an organic solution by extraction into basic aqueous solution and is isolated after acid is added to the solution

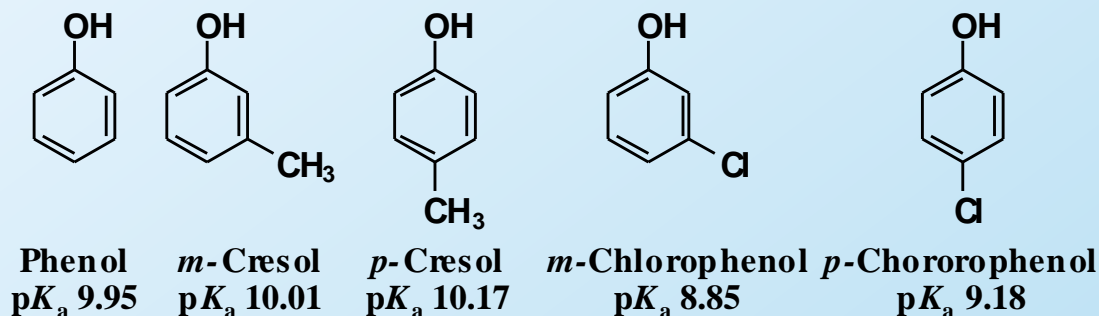


Resonance of Phenol Substitutions

- Phenols with nitro groups at the *ortho* and *para* positions are much stronger acids.




- Alkyl and halogen substituents effect acidities by inductive effects: alkyl groups are electron-releasing while halogens are electron-withdrawing.



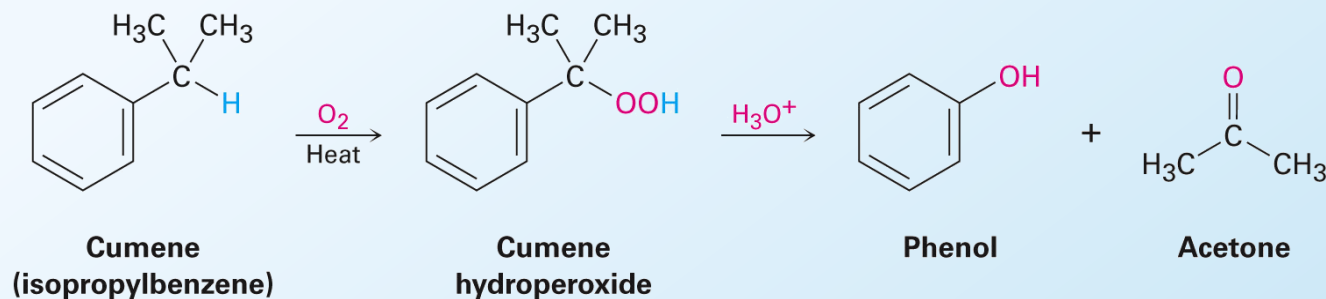
pKa of Phenols

Table 17.1 Acidity Constants of Some Alcohols and Phenols

Compound	pK _a		
(CH ₃) ₃ COH	18.00	Weaker acid	
CH ₃ CH ₂ OH	16.00		
H ₂ O	15.74		
CH ₃ OH	15.54		
CF ₃ CH ₂ OH	12.43		
<i>p</i> -Aminophenol	10.46		
CH ₃ SH	10.3		
<i>p</i> -Methylphenol	10.17		
Phenol	9.89		
<i>p</i> -Chlorophenol	9.38		
<i>p</i> -Nitrophenol	7.15		
			Stronger acid

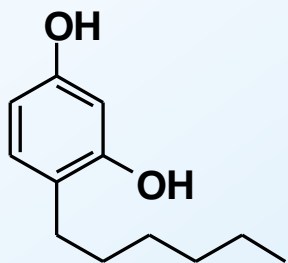
Industrial Synthesis of Phenol

- Industrial process from readily available cumene.
- Forms cumene hydroperoxide with oxygen at high temperature.
- Converted into phenol and acetone by acid.

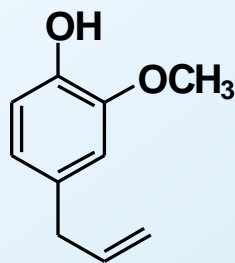


Where are Phenols Found?

- Hexylresorcinol is a mild antiseptic and disinfectant.
- Eugenol is used as a dental antiseptic and analgesic.
- Urushiol is the main component of the oil of poison ivy.



Hexylresorcinol



Eugenol

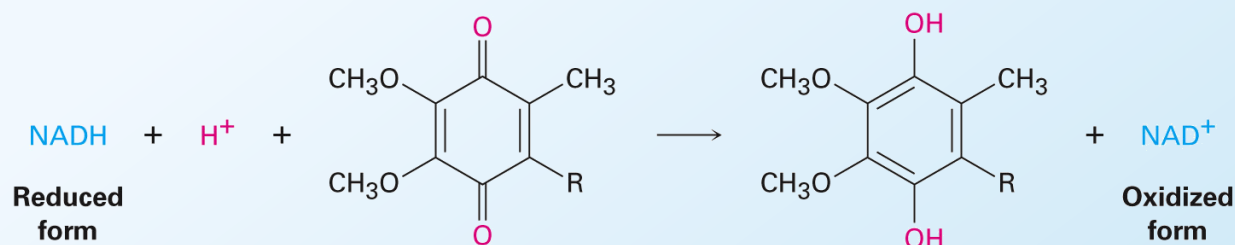


Urushiol

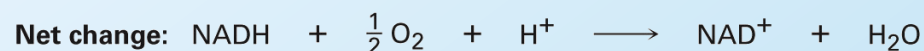
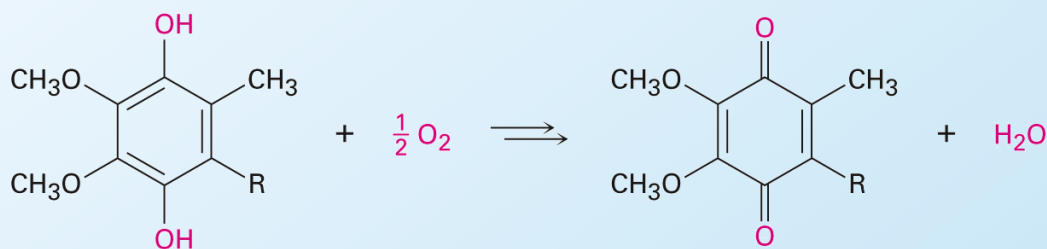
Quinones in Nature

- *Ubiquinones* mediate electron-transfer processes involved in energy production through their redox reactions

Step 1

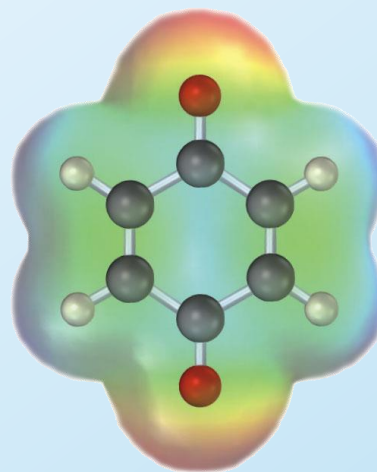
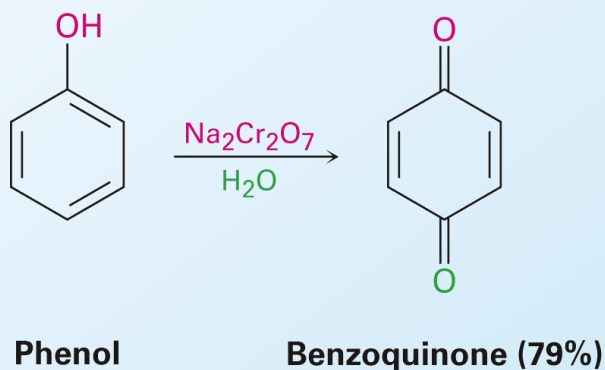


Step 2



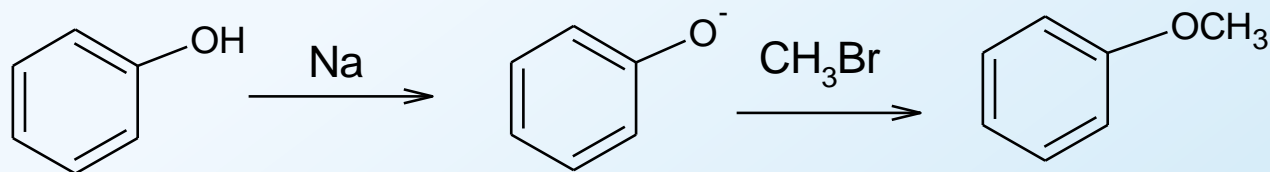
Reactions of Phenols

- The hydroxyl group is a strongly activating, making phenols substrates for electrophilic halogenation, nitration, sulfonation, and Friedel–Crafts reactions
- Reaction of a phenol with strong oxidizing agents yields a quinone

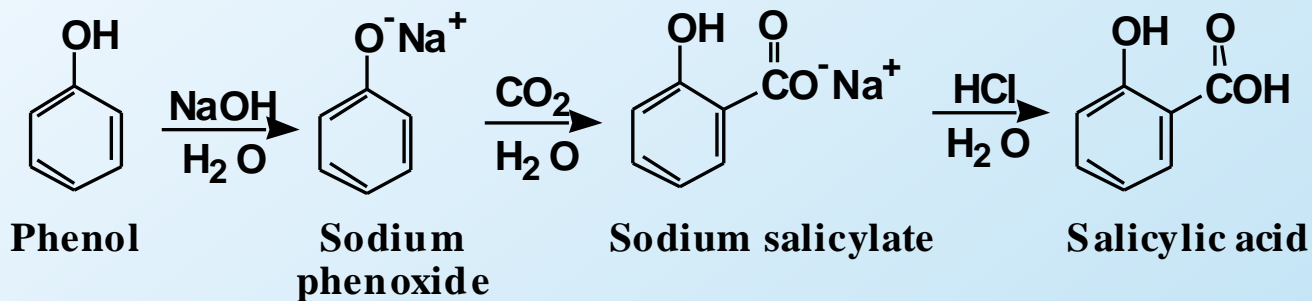


Reactions of Phenols

- Ethers: Phenols will form ethers just like alcohols through Williamson synthesis.



- Kolbe Synthesis: Addition of CO_2 to phenoxide at the ortho position to form salicylic acid. (Phenoxide's benzene ring is more activated than phenol's)



Key Concepts

- Nomenclature
- Acidity of phenols
- Ether synthesis
- Kolbe synthesis
- Oxidation of diphenols