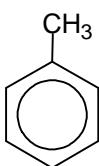
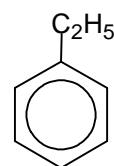


Naming aromatic molecules

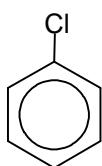
Naming aromatic compounds can be complicated. The simplest molecules are derivatives of benzene and have benzene at the root of the name



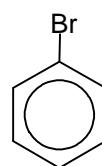
Methylbenzene



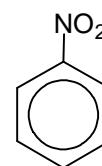
ethylbenzene



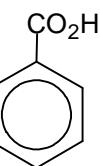
chlorobenzene



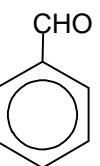
bromobenzene



nitrobenzene

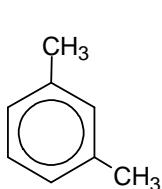


benzenecarboxylic acid

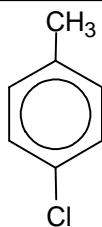


benzaldehyde

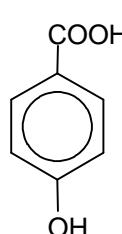
If two or more substituents are present on the benzene ring, their positions must be indicated by the use of numbers. This should be done to give the lowest possible numbers to the substituents. When two or more different substituents are present, they are listed in alphabetical order and di, tri prefixes should be used.



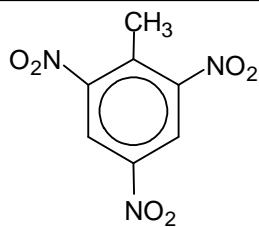
1,3-dimethylbenzene



1-chloro-4-methylbenzene

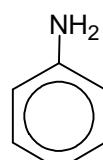


4-hydroxybenzenecarboxylic acid

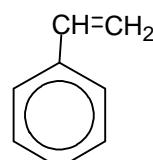


2-methyl-1,3,5-trinitrobenzene

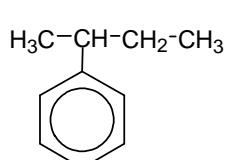
In other molecules the benzene ring can be regarded as a substituent side group on another molecule, like alkyl groups are. The C_6H_5- group is known as the **phenyl** group.



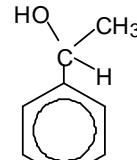
phenylamine



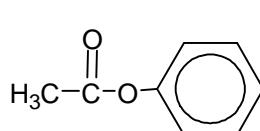
phenylethene



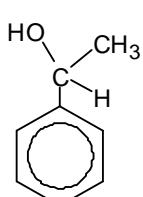
2-phenylbutane



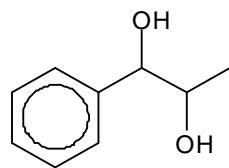
phenylethanone



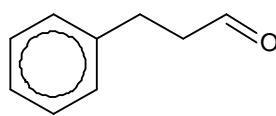
phenylethanoate



1-phenylethan-1-ol



1-phenylpropane-1,2-diol



3-phenylpropanal

Reactions of benzene

Benzene does not generally undergo addition reactions because these would involve breaking up the delocalised system. Most of Benzene's reactions involve substituting one H for another atom or group of atoms. Benzene has a high electron density and so attracts electrophiles. Its reactions are usually **electrophilic substitutions**.

Toxicity of benzene

Benzene is a carcinogen (cancers causing molecule) and is banned for use in schools. Methylbenzene is less toxic and also reacts more readily than benzene as the methyl side group releases electrons into the delocalised system making it more attractive to electrophiles.

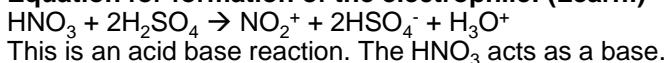
Nitration of Benzene

Change in functional group: benzene \rightarrow nitrobenzene
Reagents: conc nitric acid in the presence of concentrated sulfuric acid (catalyst)
Mechanism: Electrophilic substitution
Electrophile: NO_2^+

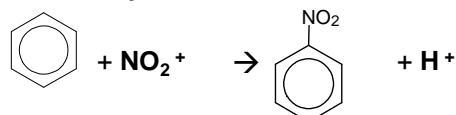
Importance of this reaction

Nitration of benzene and other arenes is an important step in synthesising useful compounds e.g. explosive manufacture (like TNT, trinitrotoluene/ 2-methyl-1,3,5-trinitrobenzene) and formation of amines from which dyestuffs are manufactured. (The reaction for this is covered in the amines section.)

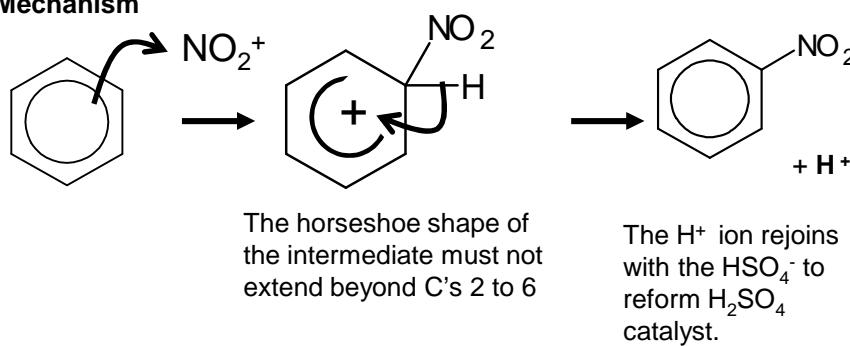
Equation for formation of the electrophile: (Learn!)



Overall equation for reaction



Mechanism



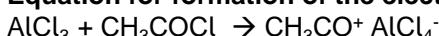
This reaction is done at 60°C . On using higher temperatures a second nitro group can be substituted.

Friedel Crafts Acylation

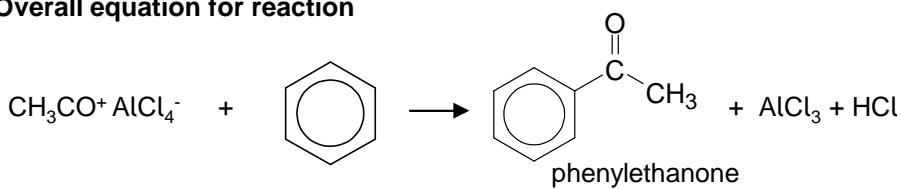
Change in functional group: benzene \rightarrow phenyl ketone
Reagents: acyl chloride in the presence of anhydrous aluminium chloride catalyst
Conditions: heat under reflux (50°C)
Mechanism: Electrophilic substitution

Any acyl chloride can be used RCOCl where R is any alkyl group e.g. $-\text{CH}_3$, $-\text{C}_2\text{H}_5$. The electrophile is the RCO^+ .

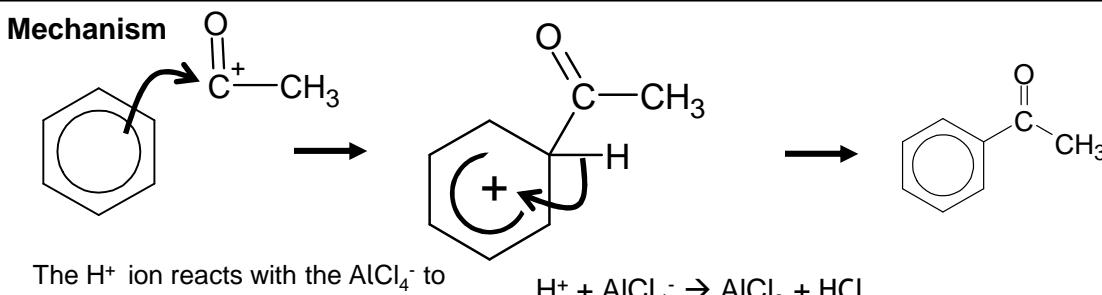
Equation for formation of the electrophile.



Overall equation for reaction



These are important reactions in organic synthesis because they introduce a reactive functional group on to the benzene ring



Reducing a Nitroarene to aromatic amines

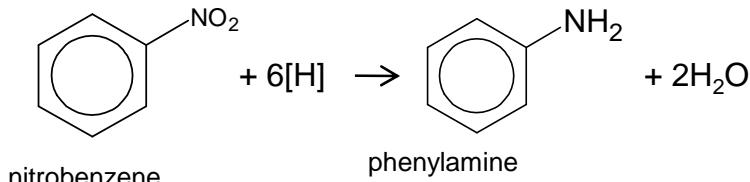
The nitro group on an arene can be reduced an amine group as follows

Reagent: Sn and HCl or Fe and HCl

Conditions: Heating

Mechanism: reduction

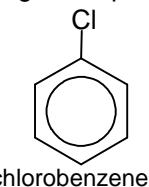
This reduction reaction can also be done with catalytic hydrogenation (H_2 using a Ni catalyst)



As the reaction is carried out in HCl, the ionic salt $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$ will be formed, which is soluble in water. Reacting this salt with NaOH will give the insoluble phenylamine.

Effect of delocalisation on side groups with lone pairs

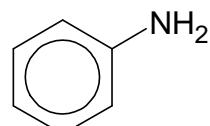
If a $-\text{OH}$ group, a Cl atom or an NH_2 group is directly attached to a benzene ring the delocalisation in the benzene ring will extend to include the lone pairs on the N , O and Cl . This changes the properties and reactions of the side group.



The C-Cl bond is made stronger. Typical halogenoalkane substitution and elimination reactions do not occur. Also the electron rich benzene ring will repel nucleophiles.



phenol



phenylamine

Delocalisation makes the C-O bond stronger and the O-H bond weaker. Phenol does not act like an alcohol- it is more acidic and does not oxidise.

Less basic than aliphatic amines as lone pair is delocalised and less available for accepting a proton.

Aromatic Synthetic Routes

Remember that many questions about aromatic compounds will actually be about normal aliphatic reactions of the side chains and not about the benzene ring.

