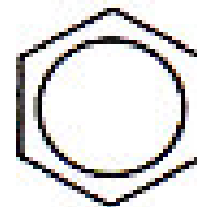
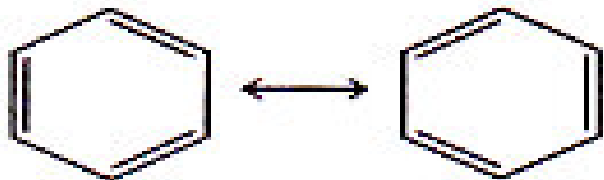


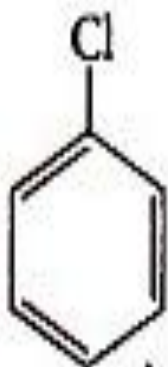
Aromatic Compounds

Benzene has a high degree of unsaturation but is unreactive. It does not undergo the usual addition reactions of alkenes and alkynes. It does react under more vigorous conditions (heat or catalysts) to form products of **substitution**. This difference in chemical reactivity is due to the structure of benzene.

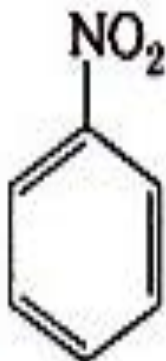


Naming Aromatic Compounds

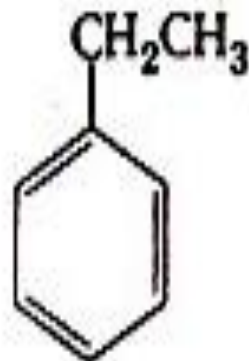
When one group is attached to benzene, the compound is named by placing the name of the group as prefix to the benzene.



Chlorobenzene



Nitrobenzene



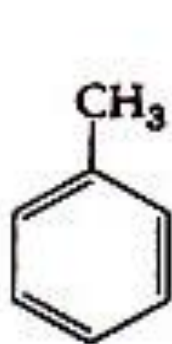
Ethylbenzene



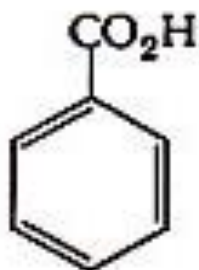
Iodobenzene



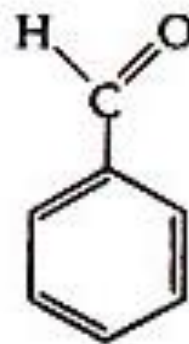
*



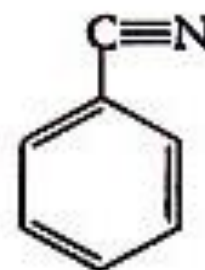
Toluene



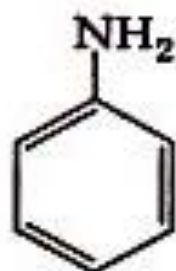
Benzoic acid



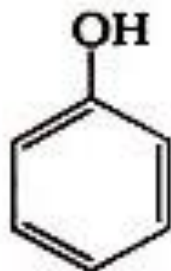
Benzaldehyde



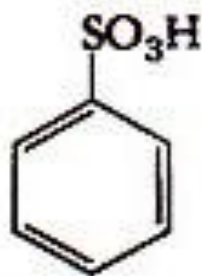
Benzonitrile



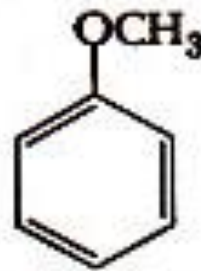
Aniline



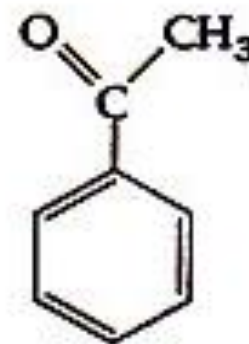
Phenol



Benzenesulfonic
acid



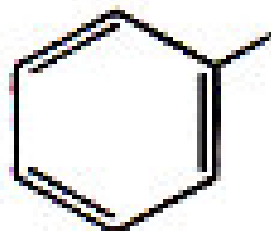
Anisole



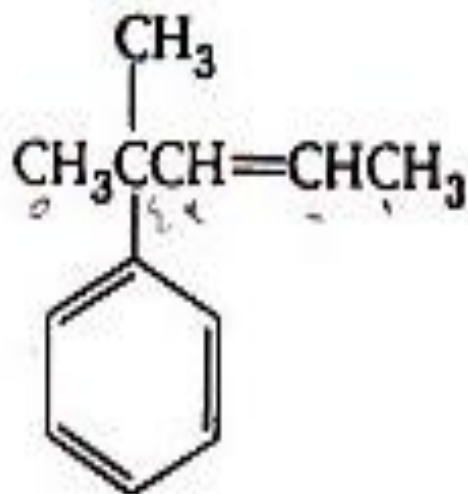
Acetophenone



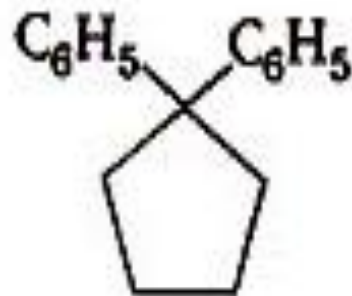
*



Phenyl group



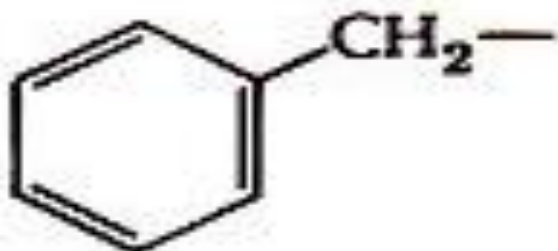
4-Methyl-4-phenyl-2-pentene



1,1-Diphenylcyclopentane

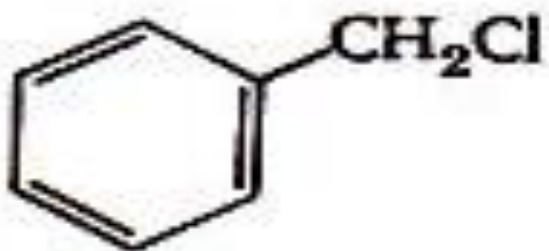


*

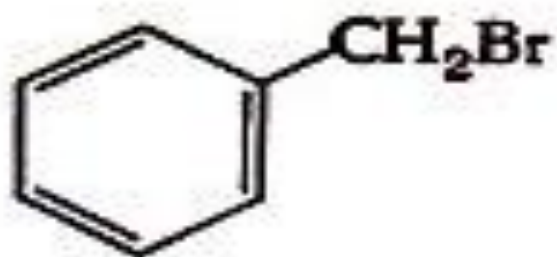


Benzyl group

For example:



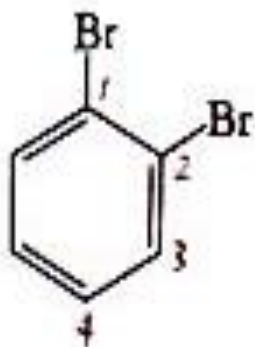
Benzyl chloride



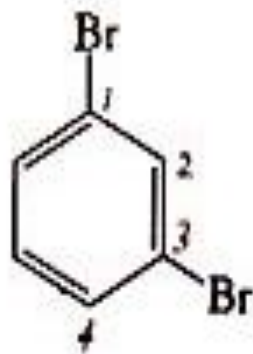
Benzyl bromide



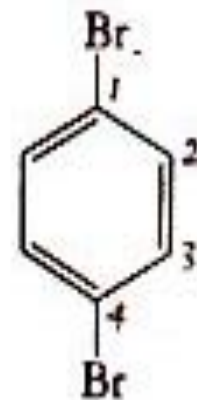
If **two groups** are attached to the benzene ring, the name must not only tell what groups are present, but also where they are located. We can differentiate the three possible isomers of a disubstituted benzene in **two ways**.



o-Dibromobenzene
1,2-Dibromobenzene



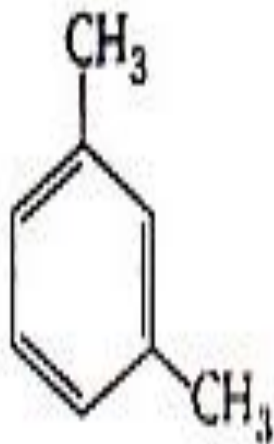
m-Dibromobenzene
1,3-Dibromobenzene



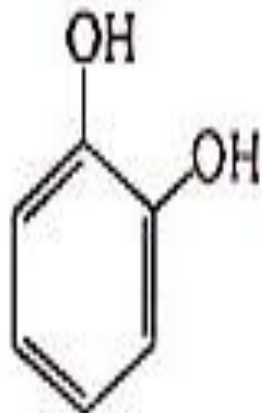
p-Dibromobenzene
1,4-Dibromobenzene



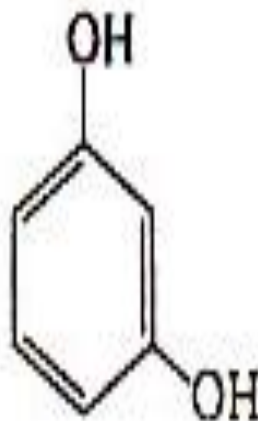
Several disubstituted benzenes have been given names that, give no indication of the kind of groups attached to the ring.



m-Xylene



Catechol



Resorcinol



Hydroquinone



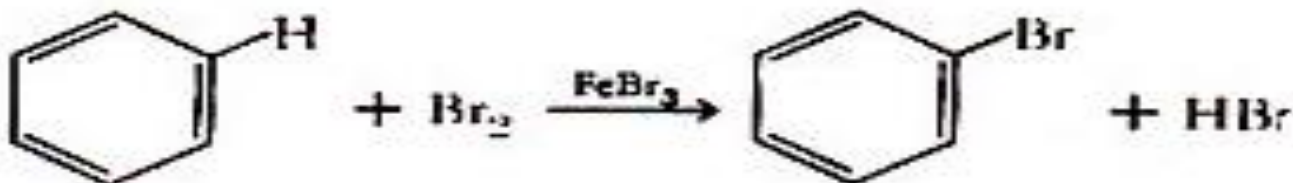
p-Cresol



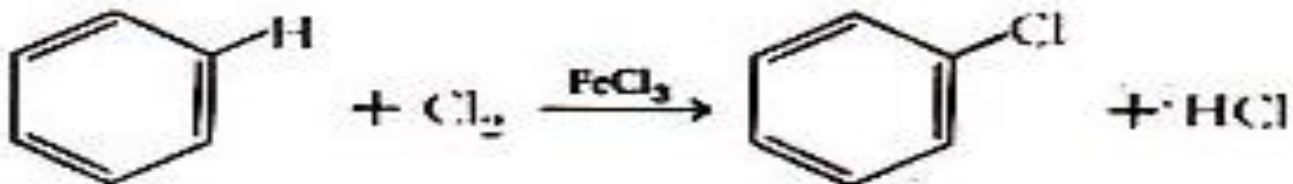
Substitution Reactions Of Aromatic Compounds

*

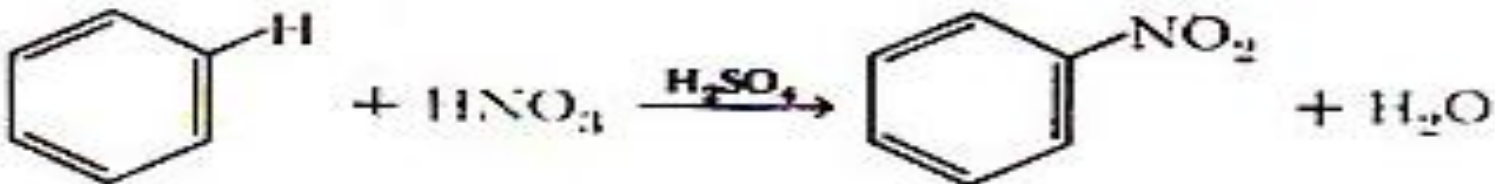
Bromination



Chlorination

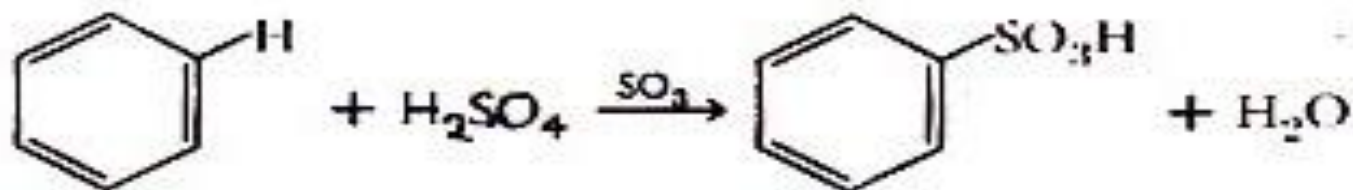


Nitration



*

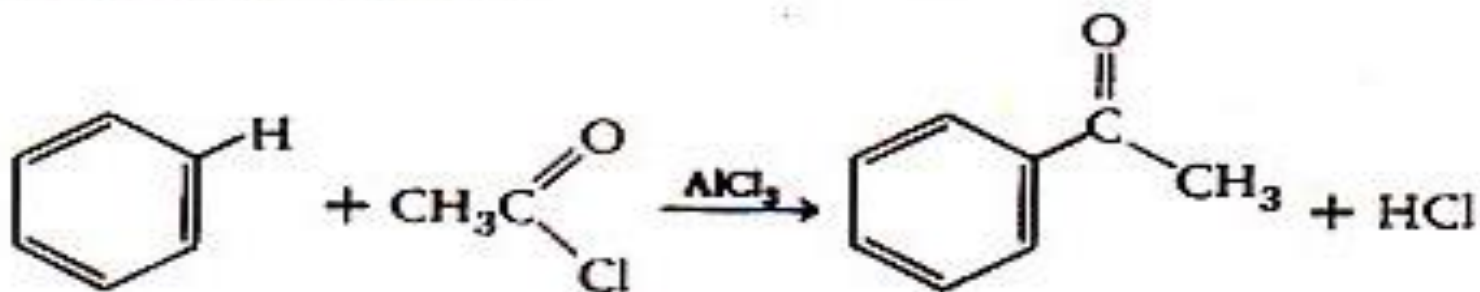
Sulfonation



Friedel-Crafts alkylation



Friedel-Crafts acylation



Toluene, nitrobenzene, chlorobenzene and many other aromatic compounds also undergo **substitution** reactions. These compounds differ from benzene in that they already have a substituent on the benzene ring. The remaining five hydrogens are not equivalent. When these hydrogens undergo substitution reactions, **isomers** can be formed depending on which hydrogen is replaced.



Examples:

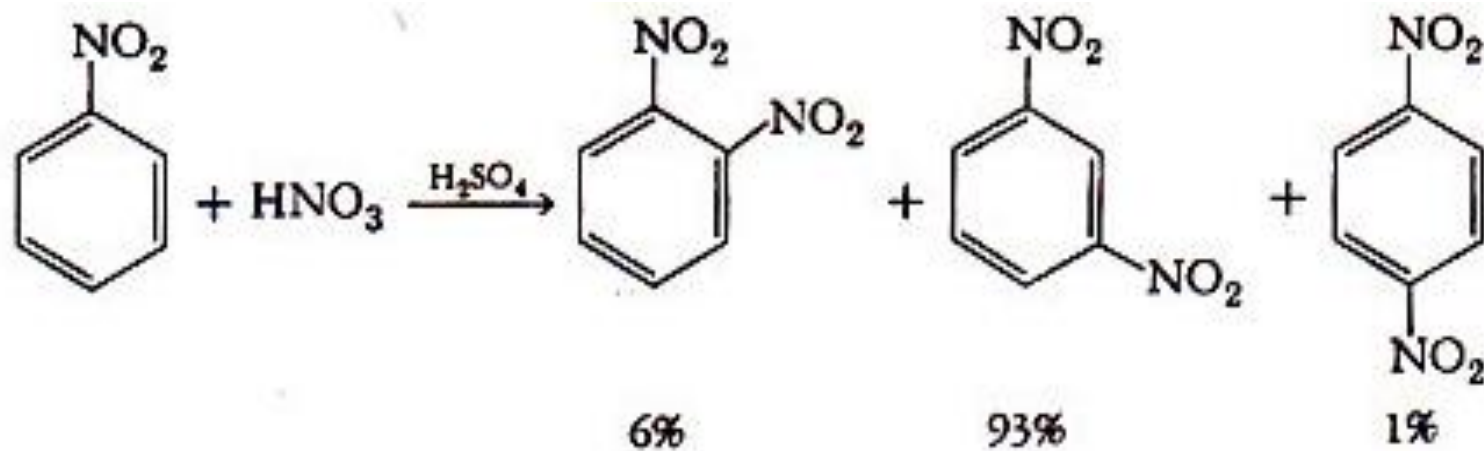
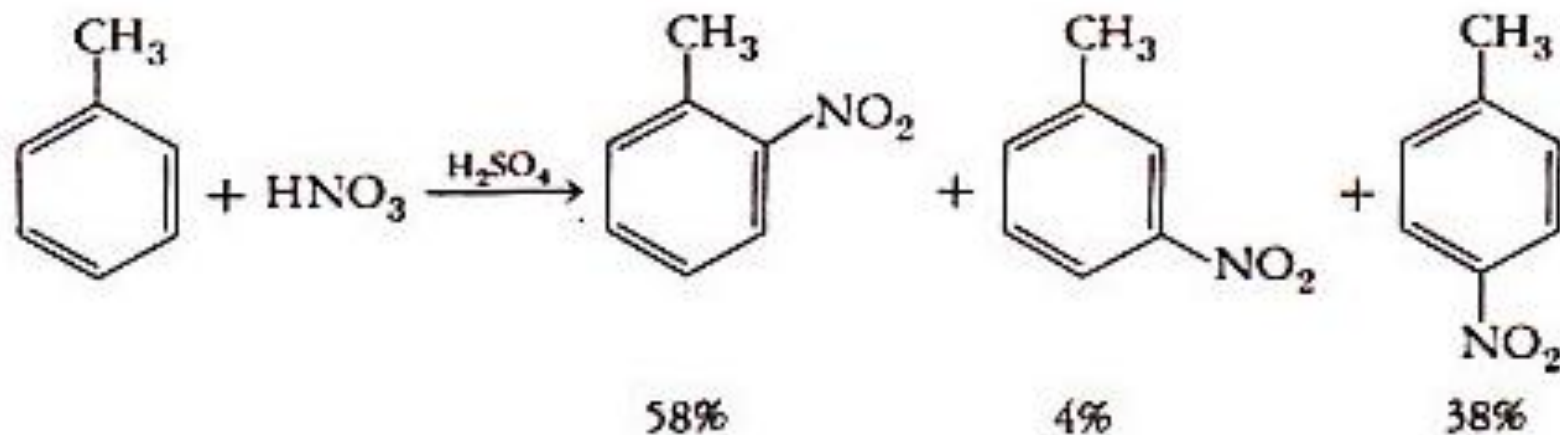


Table 13-1. Directing Effect of Substituents^a

Predominant Directing	
<i>o, p</i>	<i>m</i>
$-\text{NH}_2, -\text{NHR}, -\text{NR}_2$ $-\text{NH}_2, -\text{NHAr}, -\text{N}(\text{Ar})_2$	$-\text{NO}_2$ $-\text{CN}$
$-\text{OH}, -\text{OR}, -\text{OAr}$	$-\text{CO}_2\text{H}, -\text{CHO}, -\text{C} \begin{array}{l} \text{O} \\ \parallel \\ \text{R} \end{array}, -\text{CO}_2\text{R}, -\text{CO}_2\text{Ar}$
$-\text{NHC} \begin{array}{l} \text{O} \\ \parallel \\ \text{R} \end{array}, -\text{NHC} \begin{array}{l} \text{O} \\ \parallel \\ \text{Ar} \end{array}$	$-\text{SO}_3\text{H}$
Alkyl groups	$-\overset{+}{\text{N}}\text{H}_3, -\overset{+}{\text{N}}\text{H}_2\text{R}, -\overset{+}{\text{N}}\text{HR}_2, -\overset{+}{\text{N}}\text{R}_3$
Halogens	$-\overset{+}{\text{N}}\text{H}_3, -\overset{+}{\text{N}}\text{H}_2\text{Ar}, -\overset{+}{\text{N}}\text{H}(\text{Ar})_2, -\overset{+}{\text{N}}(\text{Ar})_3$

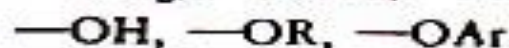
^a R = alkyl groups; Ar = aryl groups.



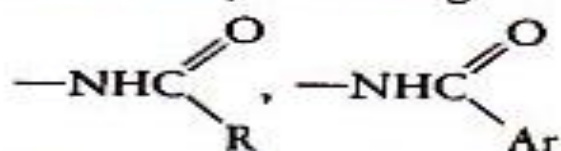
Table 13-2. Directive Influence and Effect on Reactivity of Substituents^a

I. Activating and *ortho* and *para* directing

A. Strongly activating



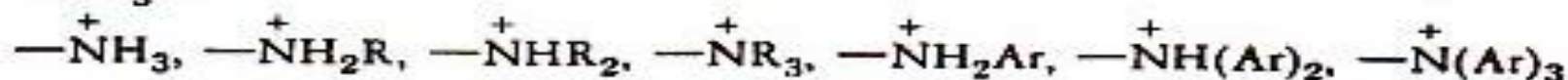
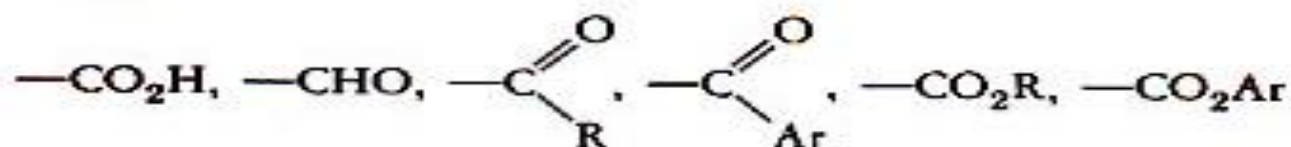
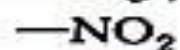
B. Moderately activating



C. Weakly activating

Alkyl groups

II. Strongly deactivating and *meta* directing



III. Deactivating and *ortho* and *para* directing

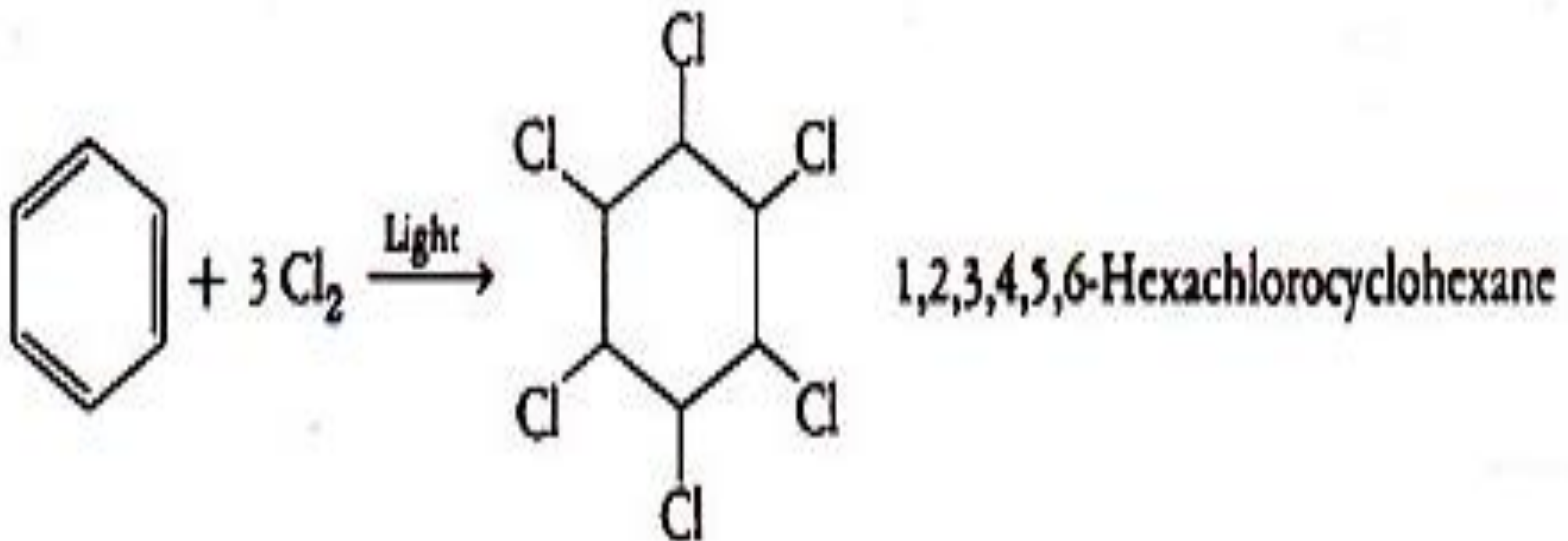
Halogens

^a R = alkyl groups; Ar = aryl groups.

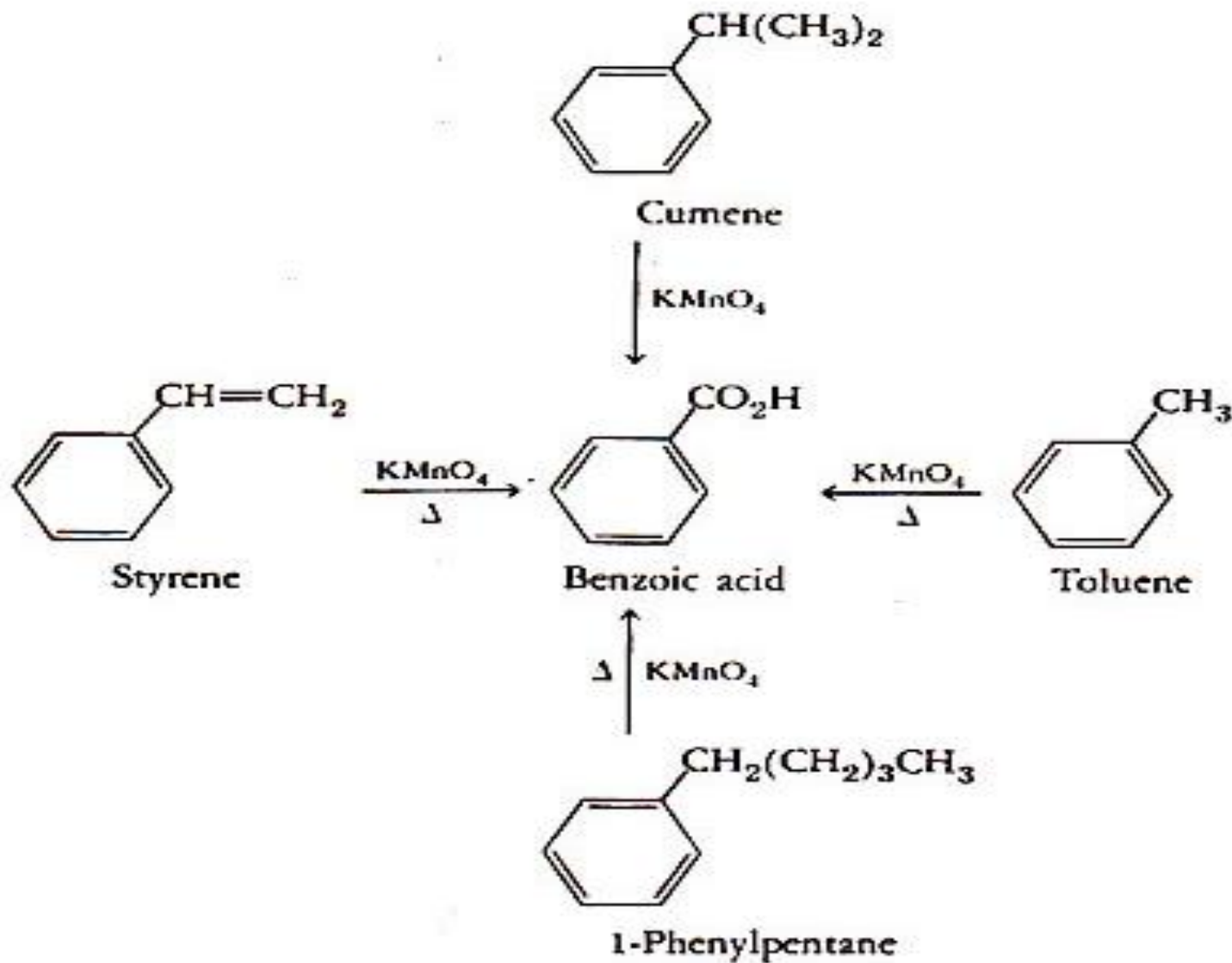


Other Reactions Of Aromatic Compounds

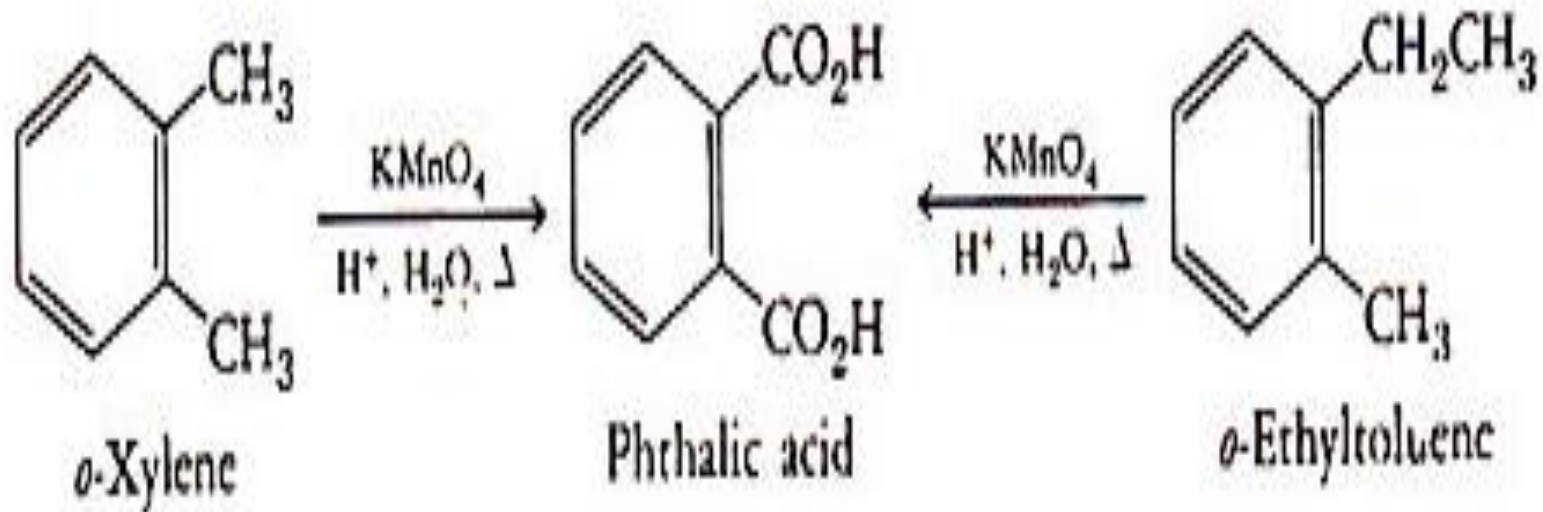
*



*

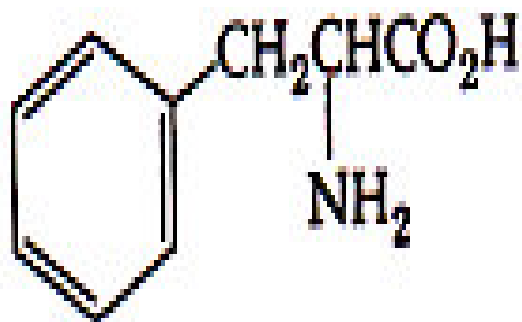


*

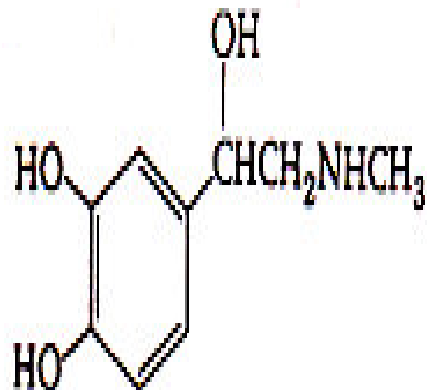


Aromatic Compounds in Nature

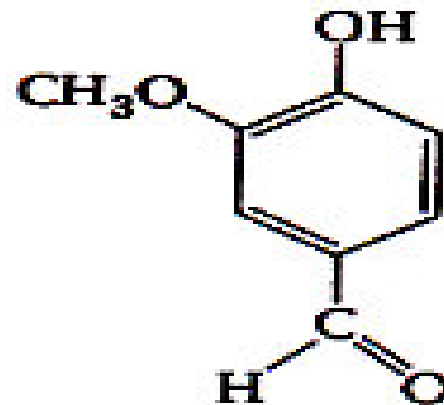
*



Phenylalanine



Epinephrine



Vanillin

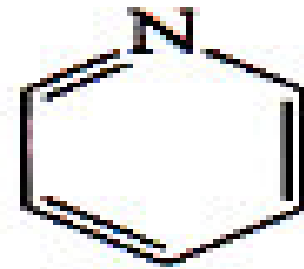
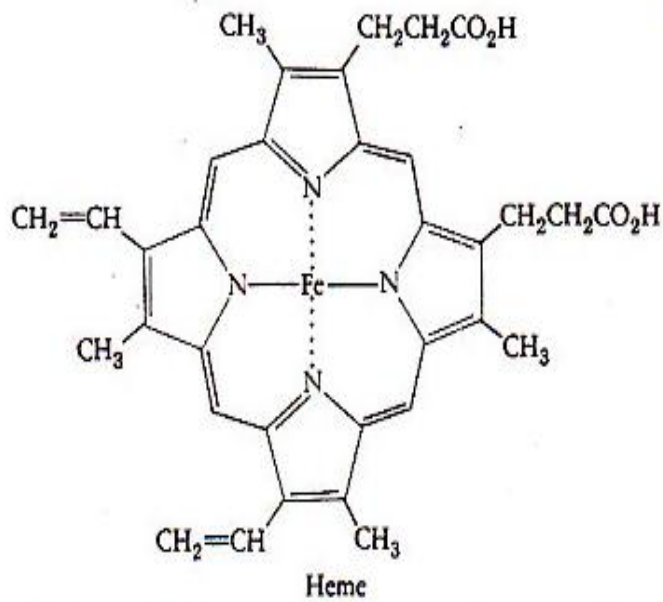


Aromatic Heterocyclic compounds

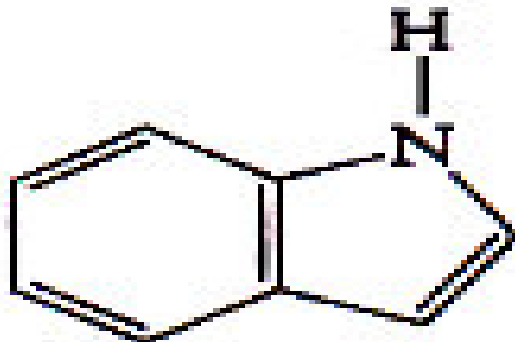
Unlike benzene, they contain at least one element other than carbon or hydrogen, usually nitrogen. These compounds, called **aromatic heterocyclic compounds**, contain a ring (or rings) in which one or more of the atoms of the ring are elements other than carbon. The other elements are called **heteroatoms**.



*



Pyridine



Indole

