



General Chemistry Theoretical

**First stage Students
Department of Physics**

Course Instructors

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2024/2025

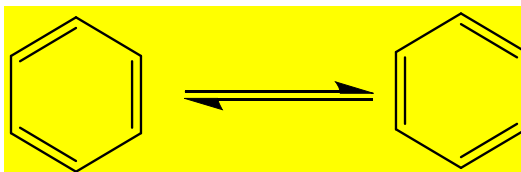
Organic Chemistry

Aromatic Hydrocarbons

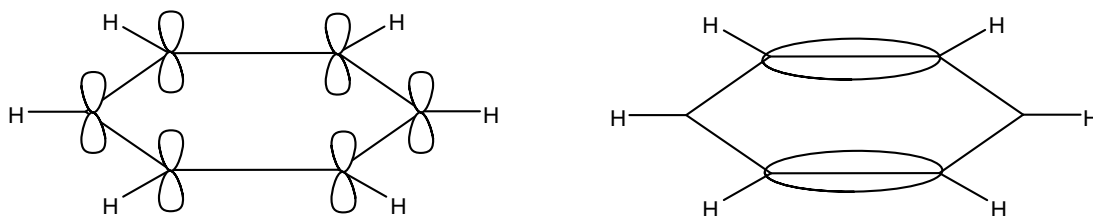
Aromatic hydrocarbons : are unsaturated compounds named so due to the aromatic scent of several of their compounds. Benzene is one of the most important among them.

Benzene

Benzene is a volatile liquid with a toxic vapor and a chemical formula of C_6H_6 . Its structural formula consists of six carbon atoms, containing both double and single bonds, forming a cyclic compound. Each carbon atom is connected to a single hydrogen atom.



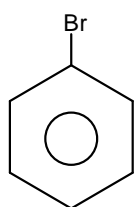
The basic structure of the benzene ring is a regular hexagonal shape, consisting of sigma bonds and π bonds.



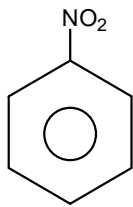
The Molecular Orbital of Benzene

Naming Benzene Derivatives

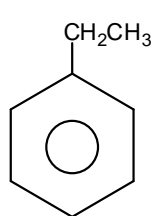
The products of single substitutions in benzene are named as benzene derivatives. For example:



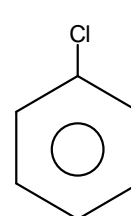
Bromobenzene



Nitrobenzene

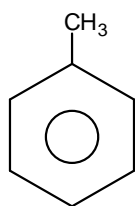


Ethylbenzene

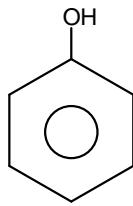


Chlorobenzene

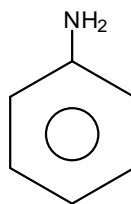
There are also specific names for single-substitution benzene derivatives that are still commonly used, as shown above.



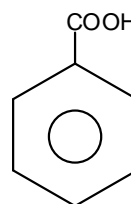
Toluene
methyl benzen



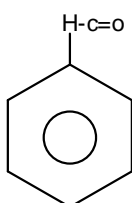
phenol



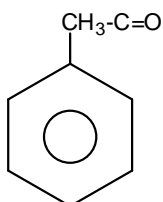
Aniline



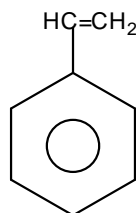
Benzoic acid



Benzaldehyde

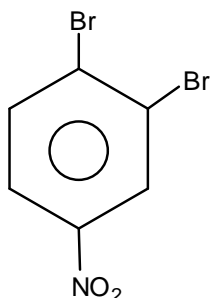


Acetophenone

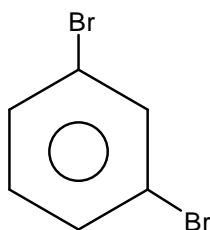


Styrene

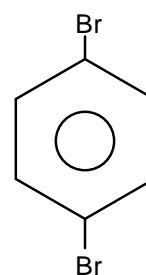
For disubstituted benzene derivatives, the carbon atoms substituted with groups are numbered using the IUPAC nomenclature system. In the old system, the terms ortho (O) (1,2), meta (m) (1,3), and para (P) (1,4) are used and abbreviated to (o, m, p) when writing, as illustrated in the examples:



1,2-dibromobenzene
O-dibromobenzene

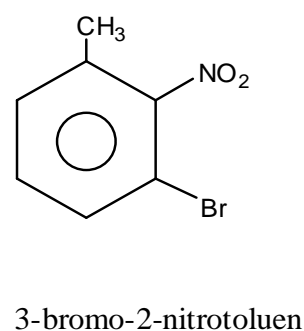
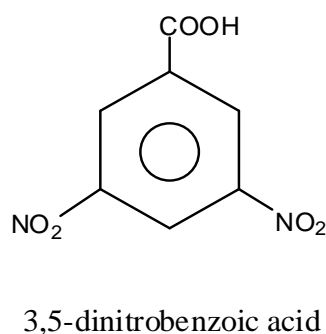
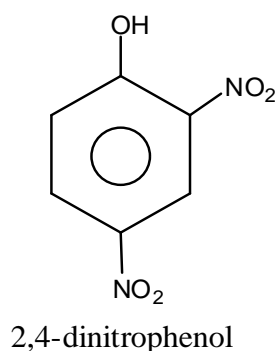


1,3-dibromobenzene
m-dibromobenzene



1,4-dibromobenze
p-dibromobenzene

For derivatives with three or more substituent groups, numbering is used to identify the locations of these groups, as shown in the following examples:

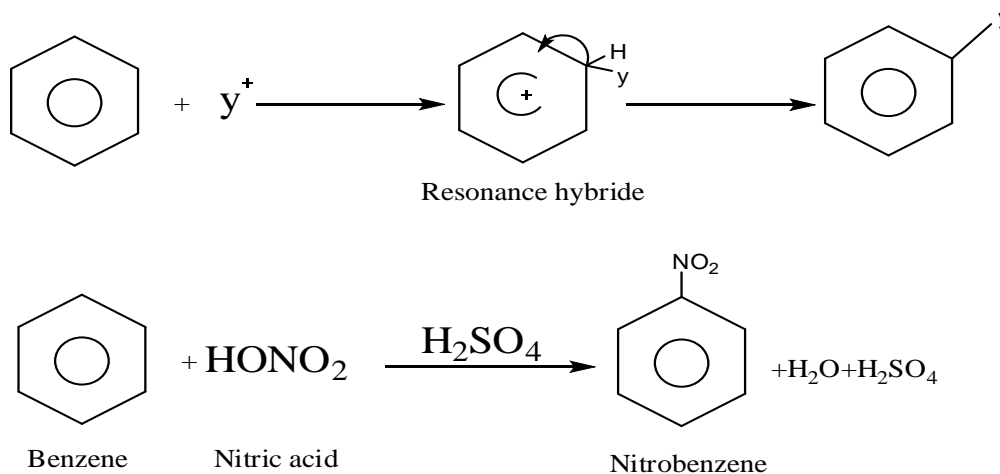


Reactions of Aromatic Hydrocarbons

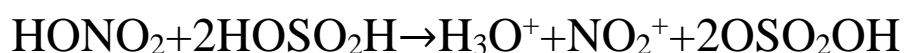
Electrophilic substitution reactions are one of the main reactions of benzene. These involve the attack of an electrophilic reagent (electron-seeking) on the π -electrons, forming a temporary bond with a carbon atom in the ring. This results in a resonance-stabilized carbocation intermediate, followed by the loss of a hydrogen atom connected to the same carbon atom, due to the action of a base.

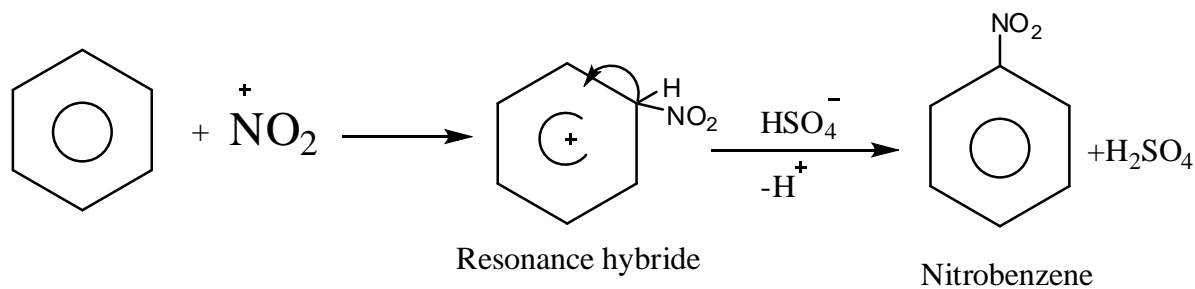
Examples of electrophilic aromatic substitution reactions include:

1. Nitration



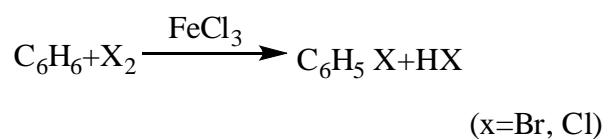
The electrophilic reagent in nitration reactions is NO_2^+ , which is produced from the following reaction:



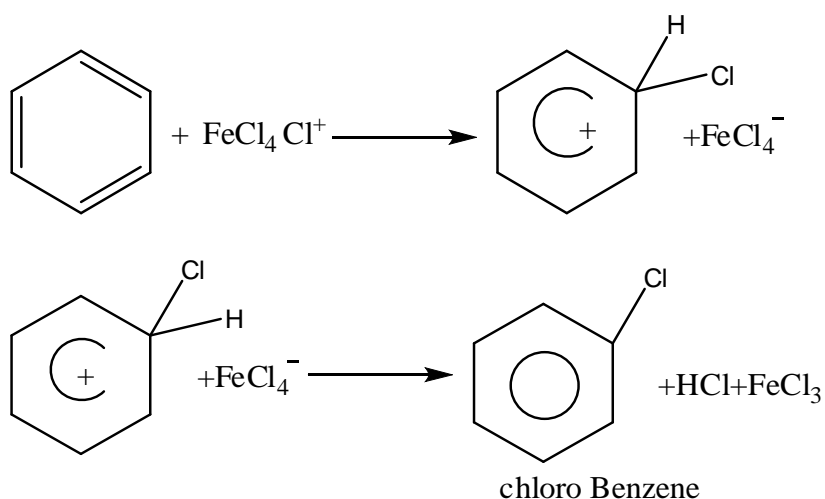
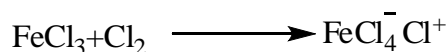


2 .Halogenation

The general equation for the halogenation of benzene is as follows:



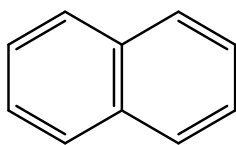
In halogenation reactions, the electrophilic reagent is X^+ , produced from the reaction of the halogen with a catalyst:



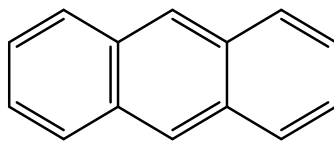
Polynuclear Aromatic Compounds

These are a group of aromatic compounds containing two or more benzene rings, which may or may not be substituted. They are primarily derived from coal tar. Naphthalene is one of

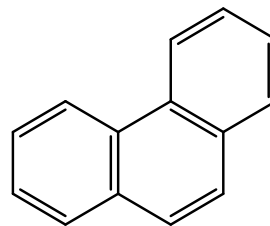
the simplest members of this group, being a solid compound containing two fused benzene rings. Other compounds include anthracene, phenanthrene, and others.



Naphthalene



Anthracene



Phenanthrene