B.Sc. Semester-II
Core Course-III (CC-III)
Organic Chemistry-I

IV. Aromatic Hydrocarbons

10. Directing Effects of Mono-Functional Groups

Dr. Rajeev Ranjan
University Department of Chemistry
Dr. Shyama Prasad Mukherjee University, Ranchi

IV Aromatic Hydrocarbons **10 Lectures**

Aromaticity: Hückel's rule, aromatic/anti-aromatic/non-aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.

Electrophilic aromatic substitution: Halogenation, Nitration, Sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of mono-functional groups.

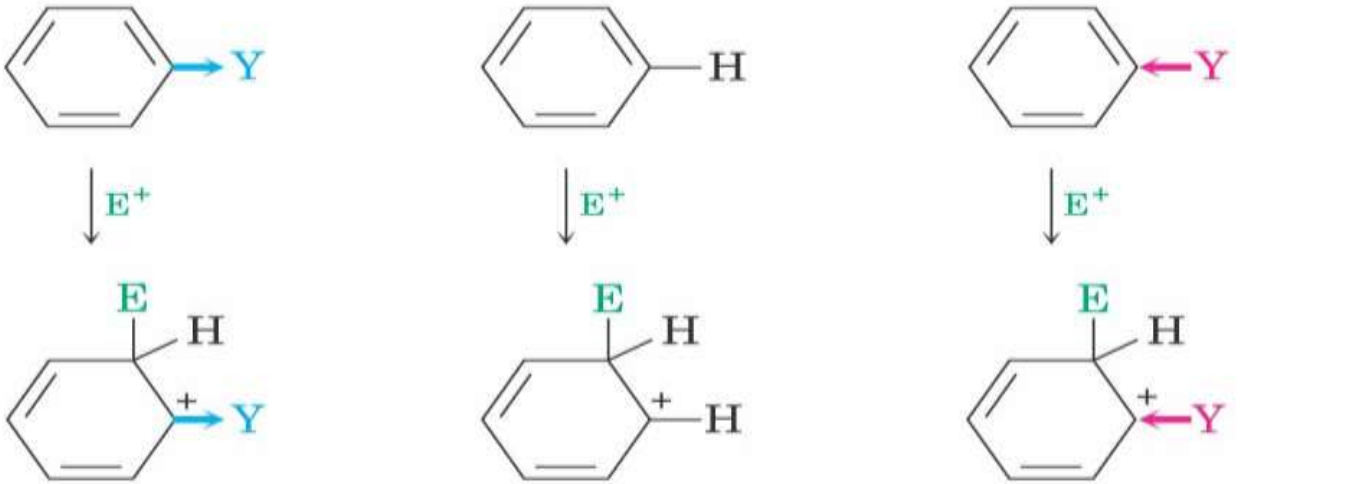
Coverage:

1. An Explanation of Substituent Effects
2. Ortho- and Para-Directing Activators
3. Ortho- and Para-Directing Deactivators
4. Meta-Directing Deactivators
5. Summary Table: Effect of Substituents in Aromatic Substitution

An Explanation of Substituent Effects

- **Activating groups donate electrons to the ring, stabilizing the Wheland intermediate (carbocation).**
- **Deactivating groups withdraw electrons from the ring, destabilizing the Wheland intermediate.**

Reactivity →



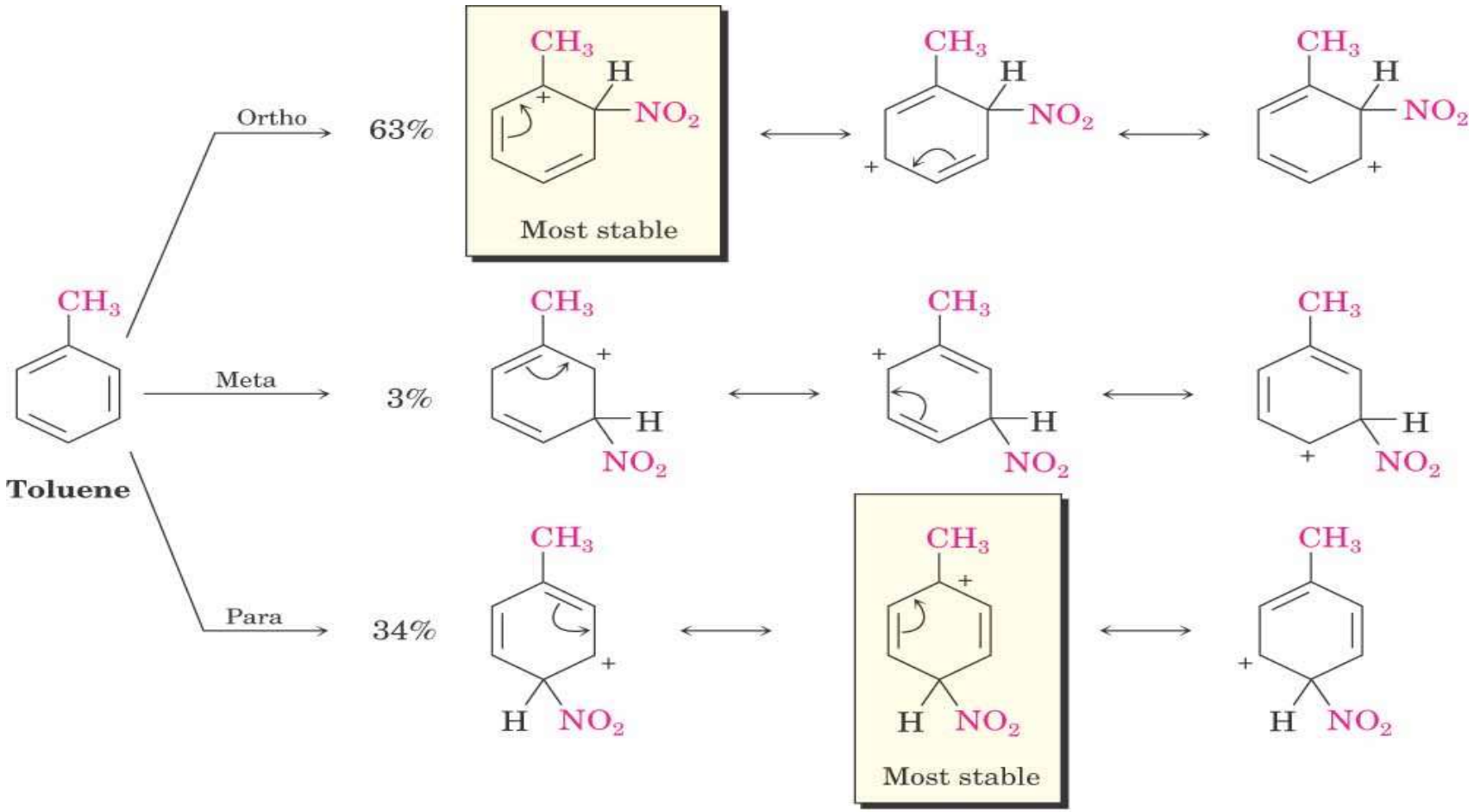
Y withdraws electrons; carbocation intermediate is less stable, and ring is less reactive.

Y donates electrons; carbocation intermediate is more stable, and ring is more reactive.

Ortho- and Para-Directing Activators

An Example : -CH_3 (or any Alkyl Group)

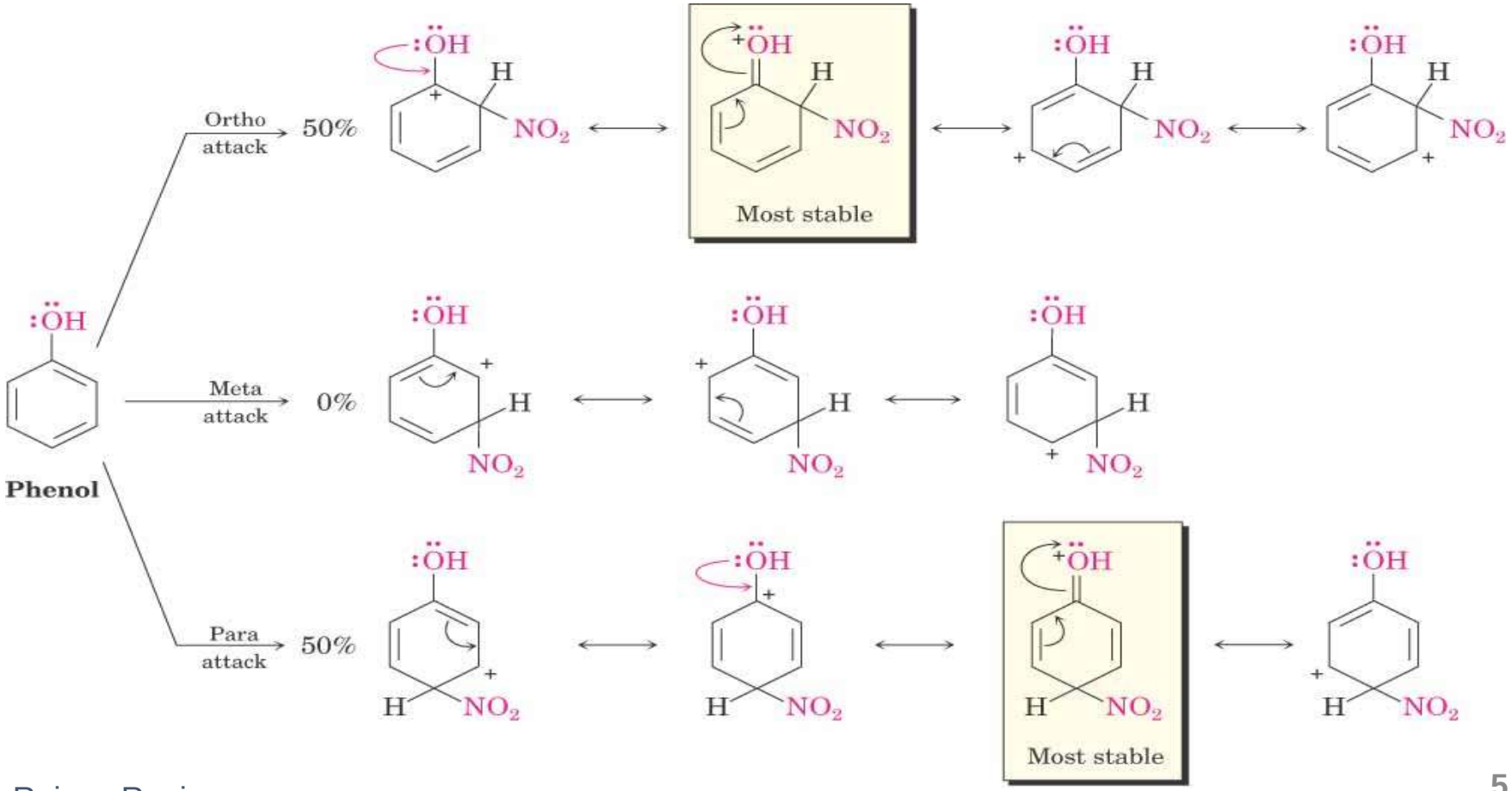
- **Alkyl groups activate: direct further substitution to positions ortho and para to themselves.**
- **Alkyl group is most effective in the ortho and para positions.**



Ortho- and Para-Directing Activators

An Example : -OH Group

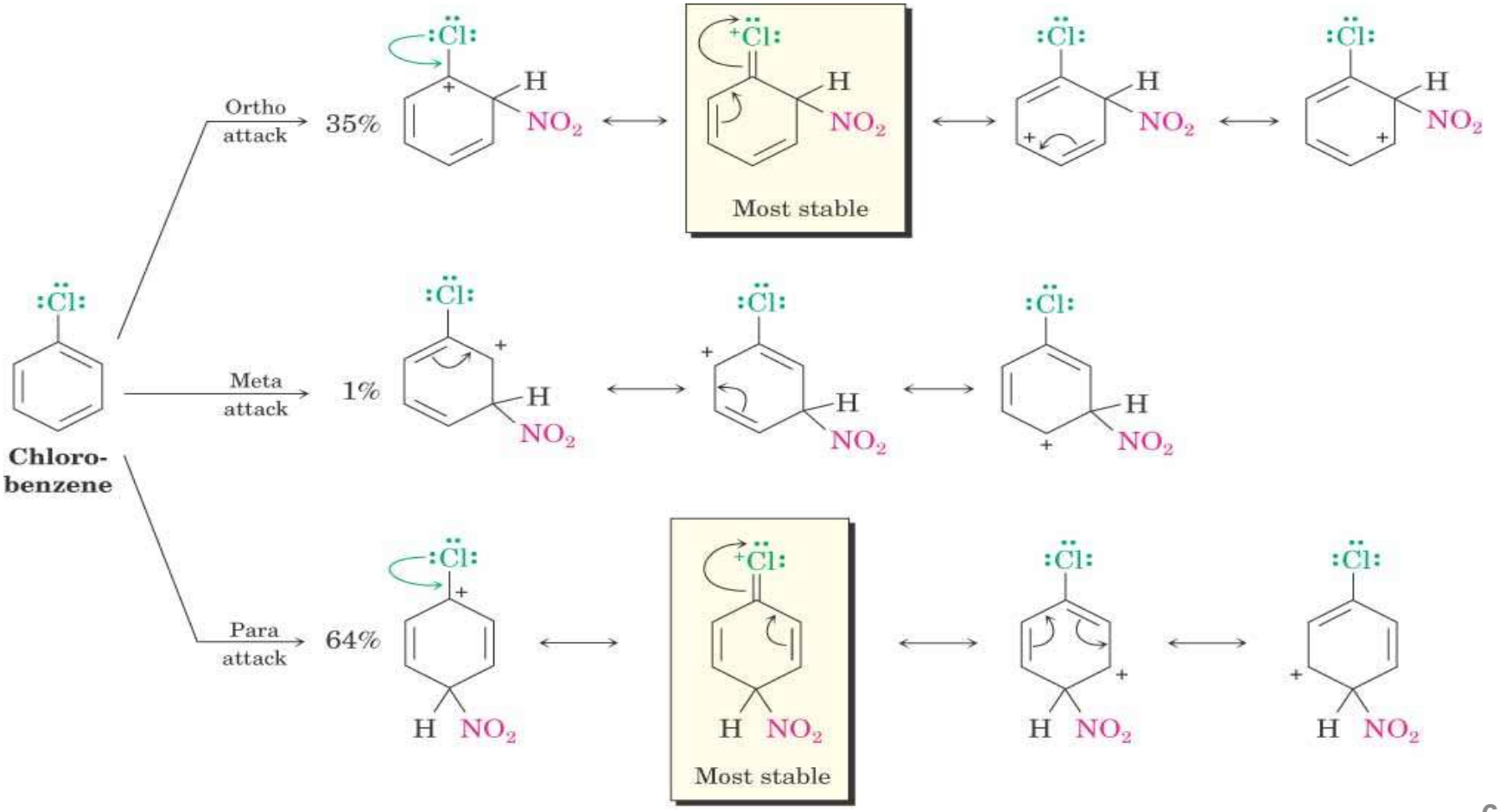
- **Alkoxyl, and amino groups have a strong, electron-donating resonance effect.**
- **Most pronounced at the ortho and para positions.**



Ortho- and Para-Directing Deactivators

An Example : -Cl Group (Halogens)

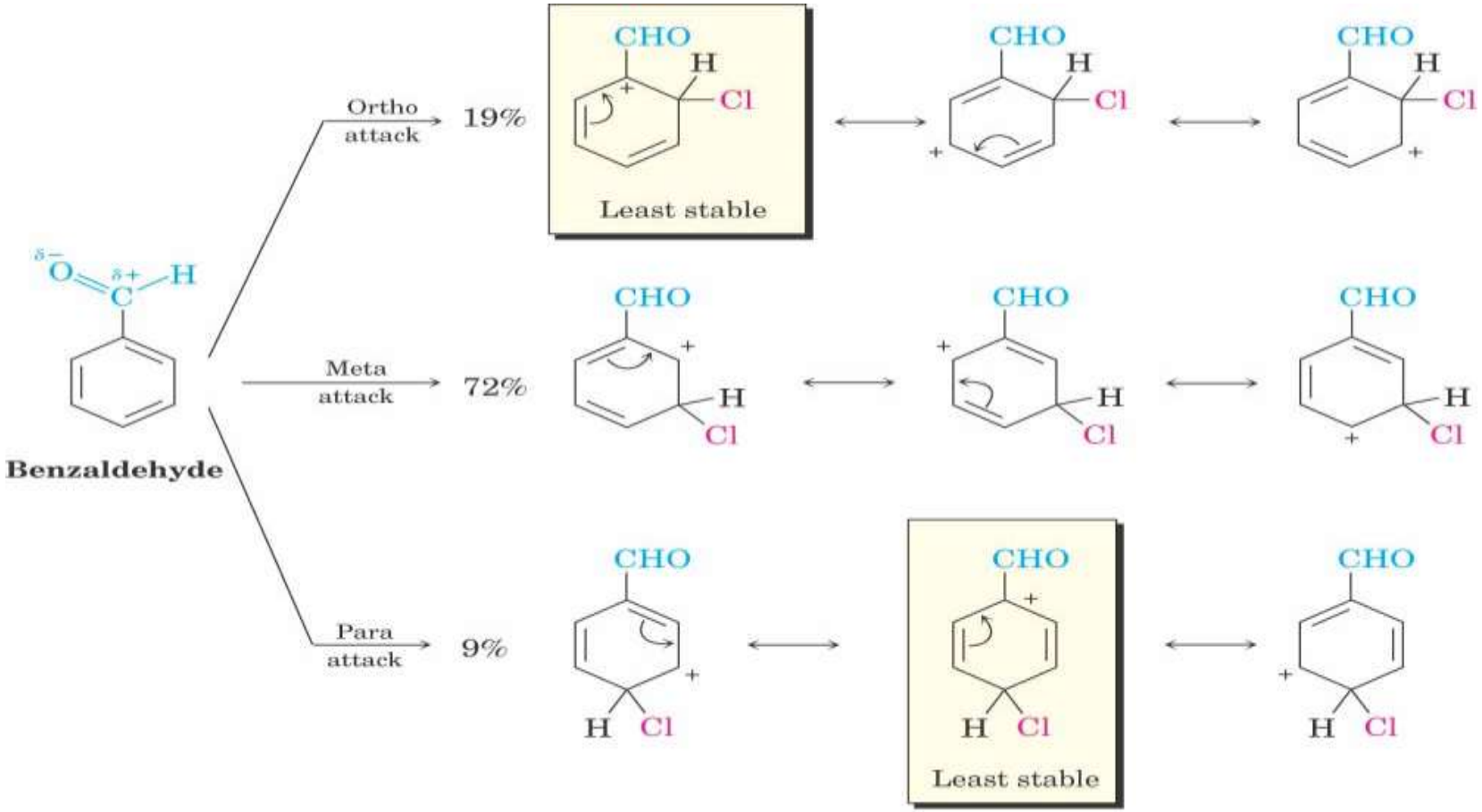
- **Electron-withdrawing inductive effect outweighs weaker electron-donating resonance effect.**
- **Resonance effect is only at the ortho and para positions, stabilizing carbocation intermediate.**



Meta-Directing Deactivators

An Example : -CHO Group

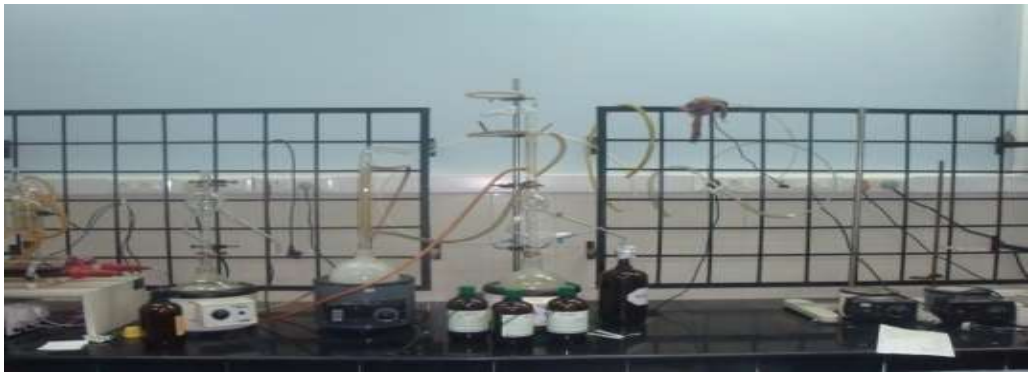
- **Inductive and resonance effects reinforce each other.**
- **Ortho and para intermediates destabilized by deactivation from carbocation intermediate.**
- **Resonance cannot produce stabilization.**



Summary Table: Effect of Substituents in Aromatic Substitution

Substituent	Reactivity	Orientation	Inductive effect	Resonance effect
$-CH_3$	Activating	Ortho, para	Weak; electron-donating	None
$-\ddot{O}H$, $-\ddot{N}H_2$	Activating	Ortho, para	Weak; electron-withdrawing	Strong; electron-donating
$-\ddot{F}:$, $-\ddot{Cl}:$, $-\ddot{Br}:$, $-\ddot{I}:$	Deactivating	Ortho, para	Strong; electron-withdrawing	Weak; electron-donating
$-\overset{+}{N}(CH_3)_3$	Deactivating	Meta	Strong; electron-withdrawing	None
$-NO_2$, $-CN$, $-CHO$, $-CO_2CH_3$, $-COCH_3$, $-CO_2H$	Deactivating	Meta	Strong; electron-withdrawing	Strong; electron-withdrawing

Thank You



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