15.1 Nomenclature of multiple-substituted benzenes
Number system easiest
Be able to recognize common names!
- ex. glucose, aniline, toluene, benzene and

15.2 Activating/deactivating groups
Effect:
Putting in an activating group means the product reacts faster than the starting material!
Putting in a deactivating group allows conversion to the desired product with fewer side reactions.

Resonance electron donation usually overcomes inducting electron withdrawal.

Exception: halogens (F, Cl, Br) are deactivating.

Resonance donation: aniline

\[
\begin{align*}
\text{H} & \quad \text{O} \quad \text{O} \\
\text{C} & \quad \text{N} \\
\text{O} & \quad \text{O}
\end{align*}
\]

Resonance withdrawal: nitrobenzene

\[
\begin{align*}
\text{H} & \quad \text{O} \quad \text{N} \quad \text{O} \\
\text{C} & \quad \text{N} \\
\text{O} & \quad \text{N}
\end{align*}
\]

Inductive donation (e.g. CH₃ group)
via "hyperconjugation"
Electron donation to a bonding MO destabilizes it, raising the energy, more reactive.
Know the list of substituents

Strong activators: resonance donors N/O

Moderate activators: resonance donor with
withdrawer

\[ \text{resonance - withdrawing substituent} \]

E.g.

\[
\begin{array}{c}
\text{donor} \\
\text{H} \\
\text{N} \\
\text{N} \\
\text{O} \\
\text{CR} \\
\end{array}
\]

Weak activator: inductive donor

(alkyl groups) or \( \text{C}=\text{C} \) bond substituent.

\[ \text{Vinylic resonance donating, but at a cost:} \]

\[
\begin{array}{c}
\text{CH}_2=\text{CH}_2 \\
\end{array}
\]

\[
\begin{array}{c}
\text{CH}=\text{CH}_2 \\
\end{array}
\]

Weak deactivators:

Resonance donors but inductive withdrawing.

Why isn't N, O in this category?

Halogen have poor Ti-orbital overlap with carbon!
Moderate deactivators: carbonyl groups
Resonance withdrawal.

Moderately strong: nitrile -\( \text{C} = \text{N} \)
Resonance withdrawal.

Strong deactivators have a formal + on the atom next to the ring AND may be resonance withdrawing.

resonance withdrawal

Not a structure seen very often; normally it's

The "expanded octet" means sulfur is highly oxidized, therefore positively charged!
15.3 

Substituent effect can be summed up:

(a) All activating groups are ortho-para directors.

(b) All resonance-donating groups are ortho directors (e.g., halogens).

(c) All strongly or moderately deactivating groups are meta directors.

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Diagram of the ortho para intermediates:

-690 (a) All activating groups stabilize formal + charge on adjacent C in resonance structures. This makes them ortho directing.

(b) All resonance donors do the same as (a).

(c) All strongly or moderately deactivating groups destabilize formal + charge on adjacent C in resonance structures. Because the groups have (formal or informal) positive charges on the atom attached to the ring. This makes them meta directing.
15.4 \( pK_a \) (as a base or acid) relates to
(a) "anion" stability which relates to
(b) whether electron in "tied up" in resonance

Therefore, electron-donating groups (which push electrons in) make bases stronger / acids weaker
Electron-withdrawing groups (which pull electrons out) make bases weaker / acids stronger

15.5 octanol-water ratio is largely related to steric factor (how big the leaving group is).
See top of p. 694

15.6 Activation / deactivation as a guide to reagent strengths, needed to carry out electrophilic substitution.

Friedel-Crafts reaction does not happen with weak-weak or strong-strong deactivating groups.

Anilines under F-C conditions form ammonium ions, which are strongly deactivating — therefore, no reaction.

NOT IN TEXT To solve this, we acylate the N before running F-C. (next page)
To design syntheses, need to understand:
(a) Directing effects. (Activating group, deactivating)
(b) Activating/deactivating effects
(c) Side chain reaction, from C4. (A)

In particular: to put in a straight chain alkylation group, put it on as the acyl group!

\[
\begin{align*}
\text{Not in text} & \quad \text{CH}_3\text{Cl} & \quad \text{H}_2\text{O} \\
\text{NH}_2 & \quad \text{Ac}_2\text{O} & \quad \text{NH}_2 \\
\text{Ac}_2\text{O} & \quad \text{Ac}_2\text{O} & \quad \text{H}_2\text{O} \\
\text{NH}_2 & \quad \text{NH}_2 & \quad \text{NH}_2 \\
\end{align*}
\]

Read this will be on the AES exam but counted as X-credit.

15.14 Read this is pretty much FYI