SUMMARY OF REACTIONS

Alkenes and Alkynes - Electrophilic Addition

\[
\text{==} + A-B \rightarrow A \quad B
\]

\[
\text{==} + 2 A-B \rightarrow A \quad B
\]

\[
A-B = \begin{cases} 
H_2 / Pd-C \\
Cl_2, Br_2 \\
HCl, HBr, HI \\
H_2O / H^+ (\text{dil} \ H_2SO_4) \text{ - alkenes only}
\end{cases}
\]

Alcohols – Acid-Base, Elimination, Oxidation

\[
R-OH + NH_2 \rightarrow R-O^- + NH_3
\]

\[
\underline{H \quad OH} + H^+ \rightarrow \text{==} + H_2O
\]

\[\text{[O]} = \text{Cr}_2O_7^{2-} / H^+\]

Amines – Acid-Base, Substitution

\[
R-NH_2 + H^+ \rightarrow R-NH_3^+
\]

\[
R_3N^- + R-X \rightarrow R_N^+ X^-
\]

\[\text{[H]} = \text{any acid}\]

Alkyl Halides – Nucleophilic Substitution and Elimination

\[
R-X + \text{Nu}^- \rightarrow R-Nu + X^-
\]

\[
\underline{H \quad X} + \text{HO}^- \rightarrow \text{==} + X^-, H_2O
\]

\[\text{Nu}^- = \begin{cases} 
\text{OH}, RO^-, RCOO^- \\
\text{NH}_2, NH_3 \\
\text{CN}
\end{cases}\]

\[\text{[H]} = \text{hot, conc. base}\]
Aldehydes and Ketones – Nucleophilic Addition and Oxidation

\[ \text{R-CHO} + [\text{O}] \rightarrow \text{R-C(OH)} \quad [\text{O}] = \text{Cr}_2\text{O}_7^{2-} / \text{H}^+ \]

\[ \text{R-C(O)}_{\text{R'}} \quad 1. \text{Nu}^\ominus \quad 2. \text{H}^+/\text{H}_2\text{O} \rightarrow \text{R}^\ominus_{\text{Nu}} \text{C}^\ominus_{\text{R'}} \quad \text{Nu}^\ominus = \left\{ \begin{array}{l} \text{LiAlH}_4 \\ \text{R-Mg-X} \\ 
\text{"H}^- \text{"} \\ \text{"R}^- \text{"} \end{array} \right\} \]

Carboxylic Acids and Derivatives – Acid/base and Nucleophilic Substitution

\[ \text{R-C(OH)} + \overset{\ominus}{\text{OH}} \rightarrow \text{R-C(O)}_{\ominus} + \text{H}_2\text{O} \quad \text{OH}^\ominus = \text{many base} \]

\[ \text{R-C(OH)} + \text{SOCl}_2 \rightarrow \text{R-C(Cl)}_{\ominus} + \text{SO}_2 + \text{HCl} \]

\[ \text{R-C(O)}_{\text{Y}} + \text{H-W} \rightarrow \text{R-C(W)}_{\ominus} + \text{H-Y} \]

<table>
<thead>
<tr>
<th>Y</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cl</td>
<td>OH, OR, NR₂</td>
</tr>
<tr>
<td>OR</td>
<td>OH, NR₂</td>
</tr>
<tr>
<td>NR₂</td>
<td>OH</td>
</tr>
</tbody>
</table>
**SUMMARY OF MECHANISMS**

**Acid/Base**

\[
\begin{array}{c}
\text{R-C} \\
\text{O} \\
\text{O-H} \\
\end{array}
\xrightarrow{\text{B}}
\begin{array}{c}
\text{R-C} \\
\text{O} \\
\text{O} \\
\end{array}
\xrightarrow{\text{HB}^+} \quad \text{R-C} \\
\text{O} \\
\text{O} \\
\end{array}
\]

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<table>
<thead>
<tr>
<th></th>
<th>pK\text{a}</th>
<th>React with</th>
<th>React with</th>
<th>React with</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NH\text{OH}</td>
<td>OH\text{OH}</td>
<td>HCO\text{OH}</td>
</tr>
<tr>
<td>Carboxylic Acid RCOOH</td>
<td>~5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Phenol         C\text{6}H\text{5}OH</td>
<td>9.9</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Alcohol        ROH</td>
<td>~16</td>
<td>✓</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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**Addition**

*Electrophilic addition*

\[
\begin{array}{c}
\text{R-CH}_2 \\
\text{CH}_2 \\
\text{R} \\
\end{array}
\xrightarrow{\delta^+} \\
\xrightarrow{\delta^-} \\
\begin{array}{c}
\text{R-C} \\
\text{CH}_3 \\
\text{R} \\
\end{array}
\xrightarrow{\delta^+} \\
\xrightarrow{\delta^-} \\
\begin{array}{c}
\text{R-C} \\
\text{X} \\
\text{R} \\
\end{array}
\]

*Nucleophilic addition*

\[
\begin{array}{c}
\text{Nu} \\
\delta^- \\
\text{R} \\
\end{array}
\xrightarrow{\delta^+} \\
\xrightarrow{\delta^-} \\
\begin{array}{c}
\text{Nu-C} \\
\text{O} \\
\text{R} \\
\end{array}
\xrightarrow{\delta^+} \\
\xrightarrow{\delta^-} \\
\begin{array}{c}
\text{Nu-C} \\
\text{OH} \\
\text{R} \\
\end{array}
\]

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**Elimination**

\[
\begin{align*}
\text{Nu}^- + \text{R}-\text{CH}_2-X & \rightarrow \text{R}-\text{CH}_2-\text{Nu} + \text{X}^-
\end{align*}
\]

**Substitution**

**Nucleophilic substitution**

**Oxidation**

\[
\begin{align*}
\text{[O]} &= \text{Cr}_2\text{O}_7^{2-} / \text{H}^+ \\
\text{R}-\text{CH}_2-\text{OH} & \xrightarrow{\text{[O]}} \text{R}-\text{C}=\text{O} \\
\text{R-CH-CH}_2-\text{OH} & \xrightarrow{\text{[O]}} \text{R'-C}=\text{O}
\end{align*}
\]

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