Catalysts are substances that increase the rate of reaction but are not consumed in the reaction.

Unsaturated hydrocarbons easily "add across multiple bonds."

\[ \text{\ce{CH=CH}} + \text{Cl}_2 \rightarrow \text{H-\ce{C-\ce{C=CH}}} \]

Even this simple reaction probably doesn't occur by a concerted mechanism.
SN = 3
trigonal

\[ x = 2 \]
\[ y = 3 \]
\[ 3x + y = 5 \]
\[ x - y = -1 \]

\[ 5 \text{Cl} - \text{Cl} \]
polarized
Saturated HCl's

Undergo Substitution reactions

\[ C_2H_6 + \overset{\text{H}}{\text{C}} - \overset{\text{Cl}}{\text{C}} - \overset{\text{H}}{\text{H}} + \overset{\text{H}}{\text{C}} \overset{\text{Cl}}{\text{Cl}} \]

Primary salt

[2b]
$\text{CH}_2 \xrightleftharpoons{} \ 2 \text{Cl}_2$

$\text{CH}_3 \text{CH}_3 + \text{Cl} \rightarrow \text{HCl} + \text{CH}_3 \text{CH}_2 \text{Cl}$

$\text{H}_3\text{C} \cdot \text{CH}_2 \cdot + \text{Cl} \rightarrow \text{H}_3\text{C} \text{CH}_2 \text{Cl}$

$\text{H}_3\text{C} \text{CH}_2 \text{Cl} + \text{Cl} \rightarrow \text{CH}_2 \text{CH}_2 \text{CH}_2 \text{Cl}$

$\text{H}_3\text{C} \cdot \text{CH}_2 \cdot + \text{CH}_3 \text{CH}_2 \rightarrow \text{CH}_3 \text{CH}_2 \text{CH}_2 \text{CH}_3$

chain mechanism
Aromatic Hydrocarbons

$C_6H_6$

3 bonds
($S +$ two $p^5$)

delocalized

1st

Resonance
Reactions with aromatic hydrocarbons occur by a different mechanism.

Aromatic hydrocarbons contain benzene or substituted benzene.

Benzene is $\text{C}_6\text{H}_6$.

Aromatics don't add across the double bonds but undergo substitution reaction.
Benzene has extra stability because of its delocalized \( \pi \) bond.

It undergoes substitution reactions rather than addition reactions.

\[
\text{C}_6\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_6\text{H}_5\text{Cl} + \text{HCl}
\]

The \( \text{FeCl}_3 \) is a catalyst.

Mechanism:

1. \( \text{Cl}_2 + \text{FeCl}_3 \rightarrow \text{Cl}^+ \cdots \text{FeCl}_4^- \)

2. \( \text{C}_6\text{H}_6 + \text{Cl}^+ \rightarrow \text{C}_6\text{H}_5\text{Cl} \)

3. \( \text{C}_6\text{H}_5\text{Cl} + \text{FeCl}_4^- \rightarrow \text{FeCl}_3 + \text{HCl} \)
Hydrogen is less reactive than halogens and the addition of H₂ across a double bond also requires catalyst.

\[
\text{H}_2 + \text{C} = \text{C} + \text{H}_2 \xrightarrow{\text{Ni}} \text{A} = \text{C} - \text{C} - \text{H}
\]

Hydrogenation is important in converting oils to solid shortening.

Fatty acids (derived from fats) are long-chain carboxylic acids.

\[
\text{CH}_3 (\text{CH}_2)_{18} \text{CH}_2 \text{COH} \quad \text{Saturated}
\]

\[
\text{CH}_3 \text{C} (\text{CH}_2)_{18} \text{CH}_2 \text{COH} \quad \text{Unsaturated}
\]

\[
\text{CH}_3 \text{C} = \text{C} - \text{CH}_2 (\text{CH}_2)_{18} \text{COH}
\]
Even exothermic reactions often require an initial input of energy before they can get started.

**Reaction Coordinate**: plot of energy change as reactants become products.

Catalysts provide a lower energy path between reactant and product.