

Reacting Systems: Chain Reactions

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Reacting Systems

- It is rare that a chemically reacting system involves only one reaction.
- More typically there are numerous reactions, up to thousands in some cases.
- However, there are certain common characteristics among reacting systems that are helpful in understanding overall behavior.



Reacting Systems

- Since I am mostly interested in combustion I will give some examples from that field.
 - Chain Reactions
 - Unimolecular Reactions
 - Hydrogen Oxidation
 - Hydrocarbon Oxidation



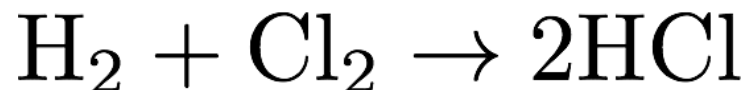
Chain Reactions

- Some chemical species are much less stable, or more reactive, than others.
- Highly reactive species are called radicals, and play an important role in chemical mechanisms.
- Complex mechanisms involving radicals will sometime display chain reaction behavior.



Example: Chlorine/Hydrogen

- Consider the global reaction

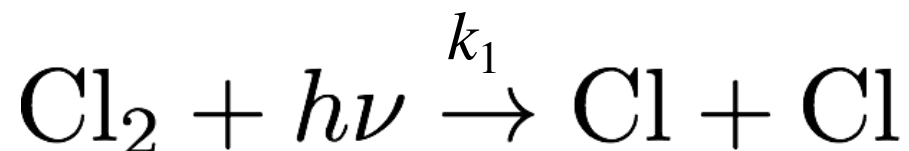


- If hydrogen and chlorine gas are mixed in a jar, they will not react. However, if a UV light source is directed into the jar, they will react explosively.



Initiation

- The UV light will cause the following reaction

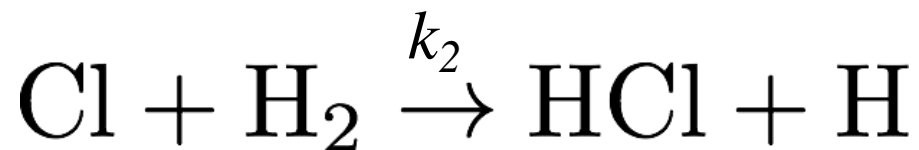


- This is called a “chain initiation” reaction because it produces radicals

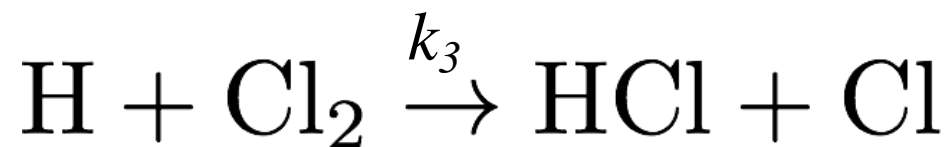


Chain Propagation

- Cl is highly reactive, and will attack H₂



- Likewise, H atoms are highly reactive and will attack chlorine molecules

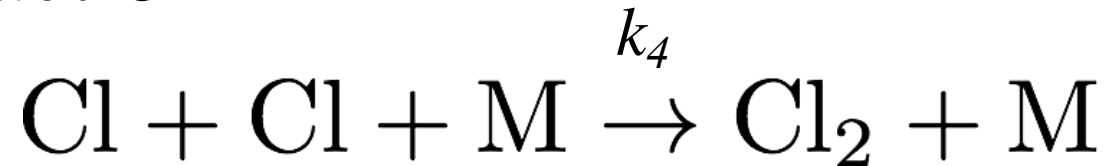


- These two reactions are called “chain carrier” or “chain propagation” reactions because the number of radicals is unaffected by them.



Termination

- The “chain” of reactions is “terminated” by the reaction



- This reaction removes radicals. It is called a “chain breaking” or “chain termination” reaction.



Chain Reactions in Combustion

- In combustion, ignition is controlled by the chain initiation reactions.
- The chain carrying reactions are generally fast and radical concentrations small.
- The chain termination reactions are “rate limiting” meaning that the overall rate of the global process is controlled by them.

