Organic Reactions

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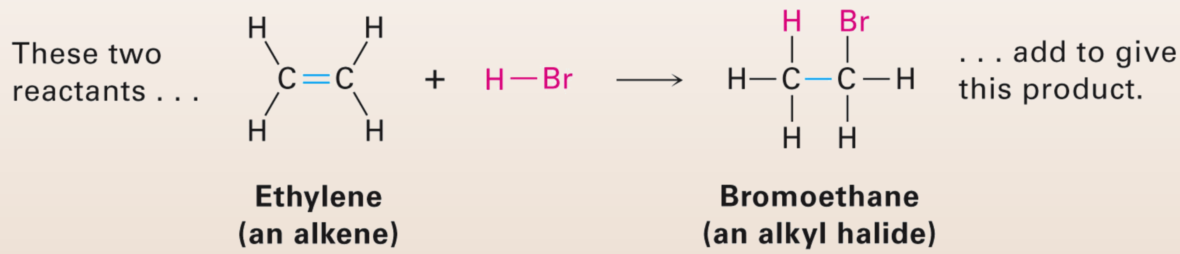
Reaction Mechanism

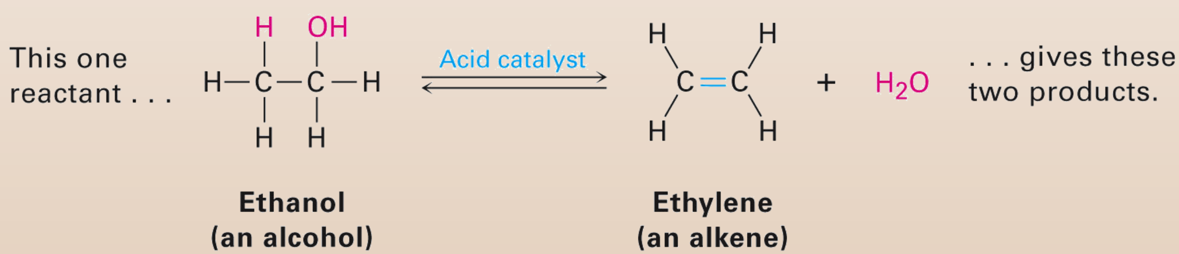
- How reactions take place
- What bonds break and make as reaction progress
- Drawing curved arrows
- Determining if a reaction can take place

Types of Reactions

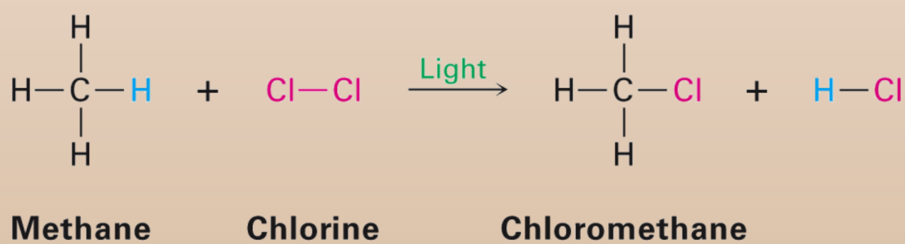
- Addition



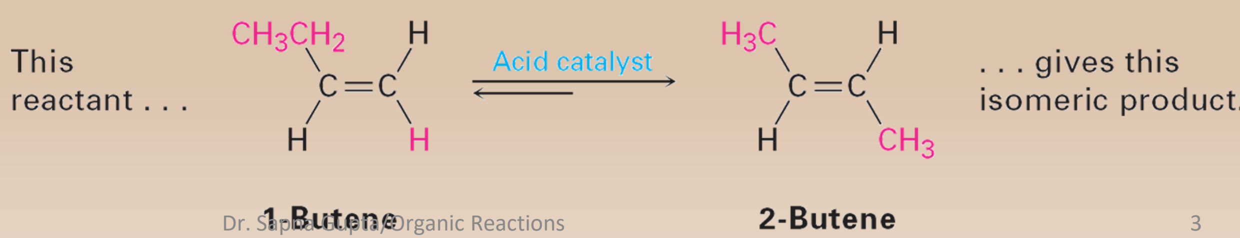
- Elimination



- Substitution

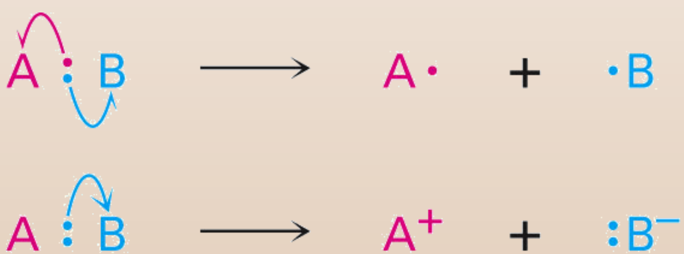


- Rearrangement



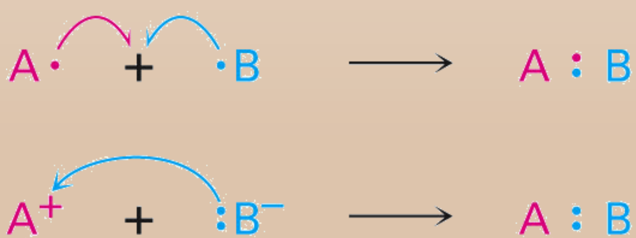
Steps in Reaction Mechanism

- Bond formation or breakage can be symmetrical or unsymmetrical
  - **Symmetrical-** homolytic
  - **Unsymmetrical-** heterolytic



Symmetrical bond-breaking (radical):
one bonding electron stays with each product.

Unsymmetrical bond-breaking (polar):
two bonding electrons stay with one product.

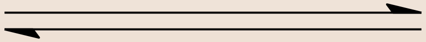


Symmetrical bond-making (radical):
one bonding electron is donated by each reactant.

Unsymmetrical bond-making (polar):
two bonding electrons are donated by one reactant.

Review - Arrows

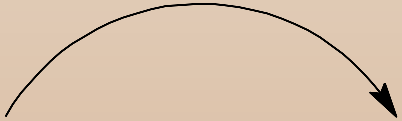
synthesis (yield)



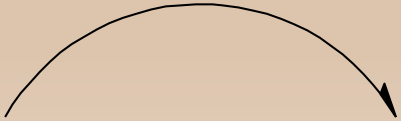
equilibrium

resonance

retrosynthesis (backward)



transfer of two electrons



transfer of one electron

Polar Reactions

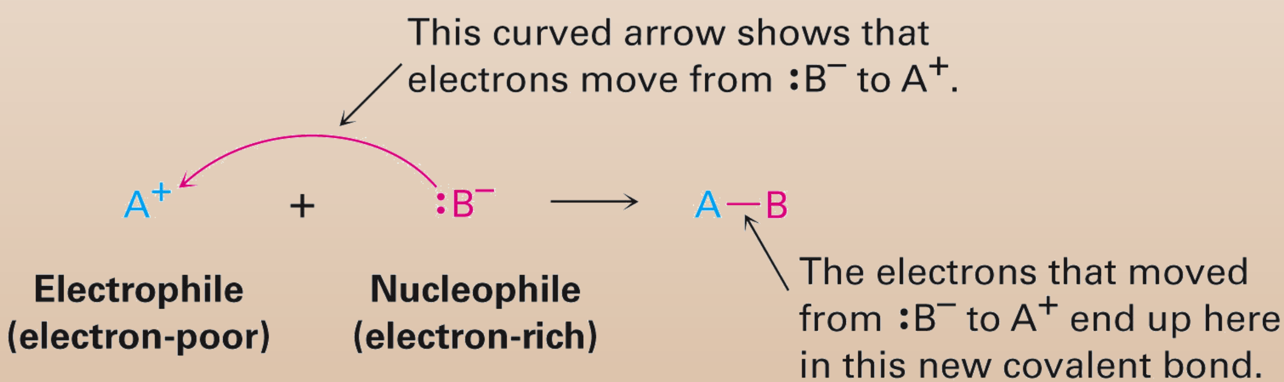
- Reactions occur at polar bonds.
- The more electronegative element has a negative charge (like a Lewis base)
- The atom bonded to the electronegative atom will have a partially positive charge (Lewis acid)
- Elements such as O, F, N, Cl are more electronegative than carbon

Table 6.1 Polarity Patterns in Some Common Functional Groups

Compound type	Functional group structure	Compound type	Functional group structure
Alcohol	$-\overset{\delta+}{C}-\overset{\delta-}{OH}$	Carbonyl	$\overset{\delta+}{C}=\overset{\delta-}{O}$
Alkene	$C=C$ Symmetrical, nonpolar	Carboxylic acid	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-\overset{\delta-}{O}H$
Alkyl halide	$-\overset{\delta+}{C}-\overset{\delta-}{X}$	Carboxylic acid chloride	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-\overset{\delta-}{Cl}$
Amine	$-\overset{\delta+}{C}-\overset{\delta-}{NH_2}$	Thioester	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-\overset{\delta-}{S}-C$
Ether	$-\overset{\delta+}{C}-\overset{\delta-}{O}-\overset{\delta+}{C}-$	Aldehyde	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-H$
Thiol	$-\overset{\delta+}{C}-\overset{\delta-}{SH}$	Ester	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-\overset{\delta-}{O}-C$
Nitrile	$-\overset{\delta+}{C}\equiv\overset{\delta-}{N}$	Ketone	$-\overset{\delta+}{C}(=\overset{\delta-}{O})-C$
Grignard reagent	$-\overset{\delta-}{C}-\overset{\delta+}{Mg}Br$		
Alkyllithium	$-\overset{\delta-}{C}-\overset{\delta+}{Li}$		

Polarized Reaction

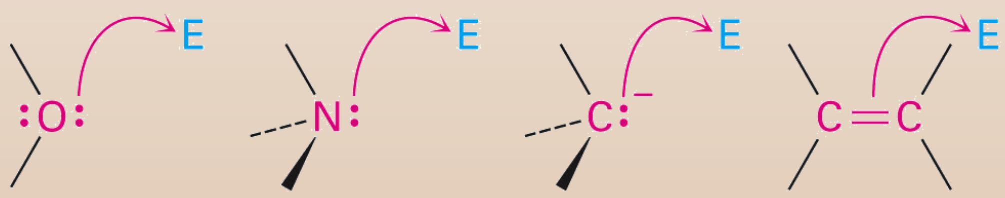
The Lewis acid	The Lewis base
• positive center • electron poor • the electrophile	• negative center • electron rich • the nucleophile

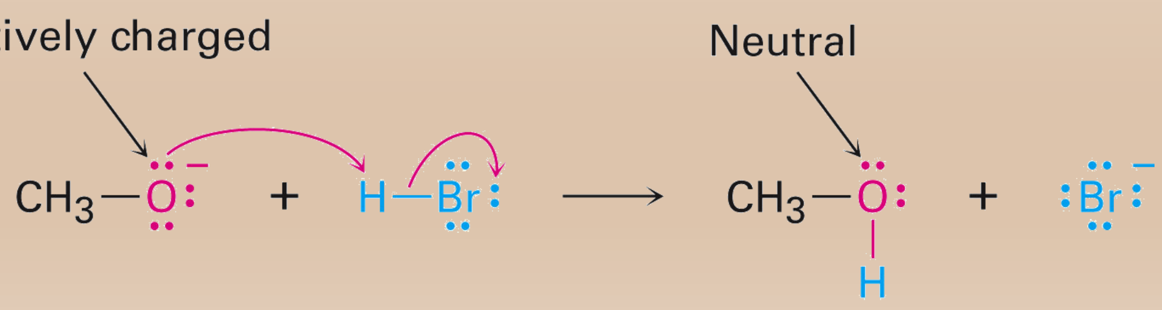


Arrows in Reaction Mechanism

- Keep a track of movement of electrons with arrows
- Always start from electron rich species (Lewis base)
- Always bring the arrow to electron poor species (Lewis acid)
- The atoms where the arrow starts and ends are the atoms that form a bond or break

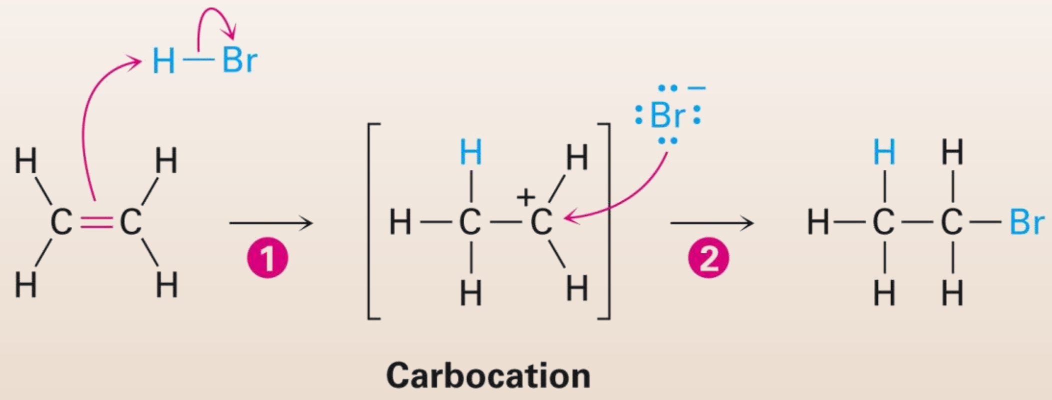
Electrons usually flow *from* one of these nucleophiles.

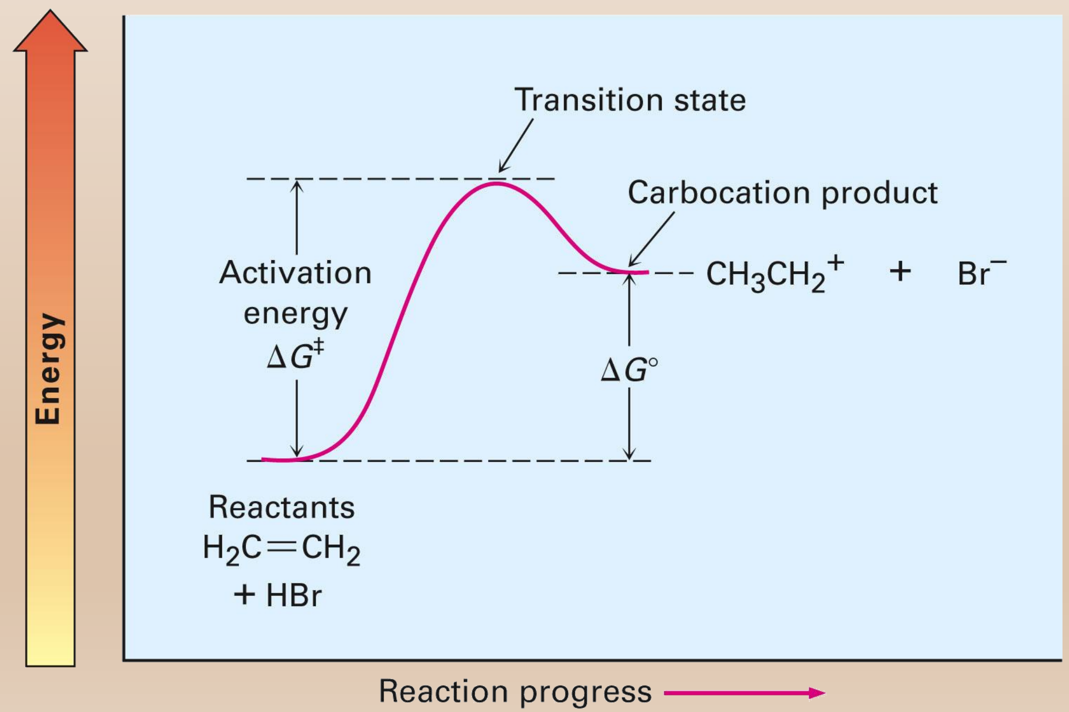




Kinetics

- Mechanisms in organic chemistry are explained by kinetics
- Transition states tell us what species are forming during the reaction
- Activation energy is the minimum energy required to get to the transition state
- Order of reaction tells us about the mechanism of the reaction.





Key Words/Concepts

- Reaction Types
- Addition
- Elimination
- Substitution
- Rearrangement
- Polarity of bond
- Electrophile
- Nucleophile
- Heterolytic cleavage
- Homolytic cleavage
- Reaction mechanisms
- Transition states
- Activation energy