

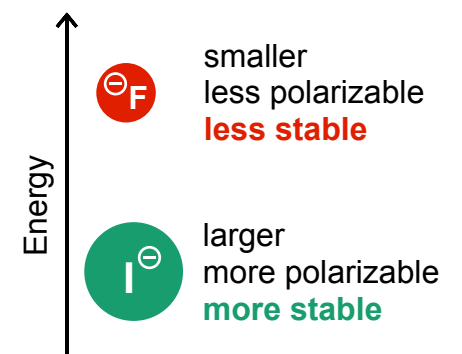
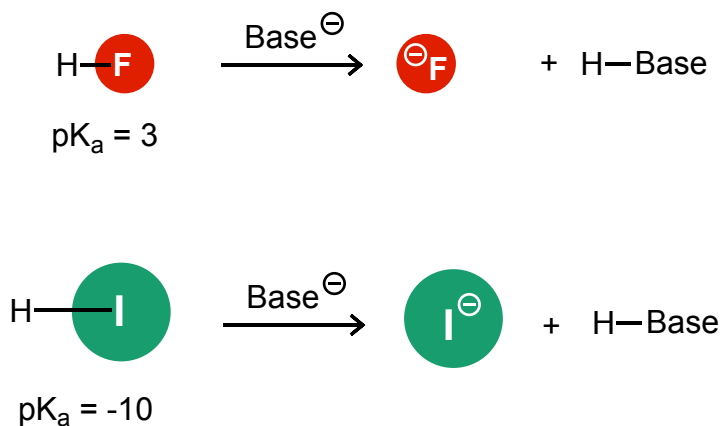
Stability

In general, **nature prefers stable, low energy species** over reactive, high energy species. In this sheet, you will see the **two main ways** that to consider the **energetics** of organic molecules: **electronics** and **sterics**.

Electronics

concerned with the "**location**" or **placement** of electrons

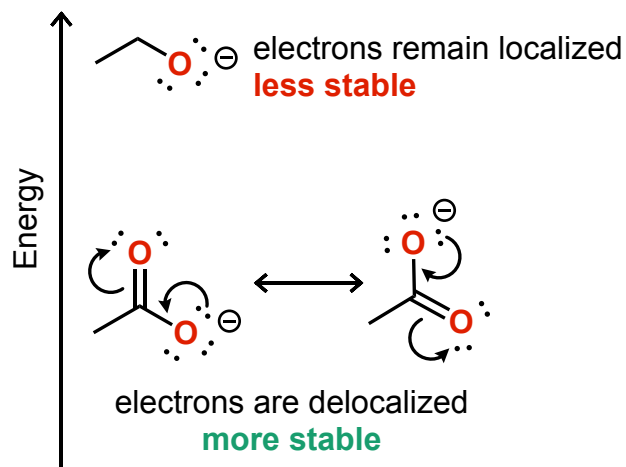
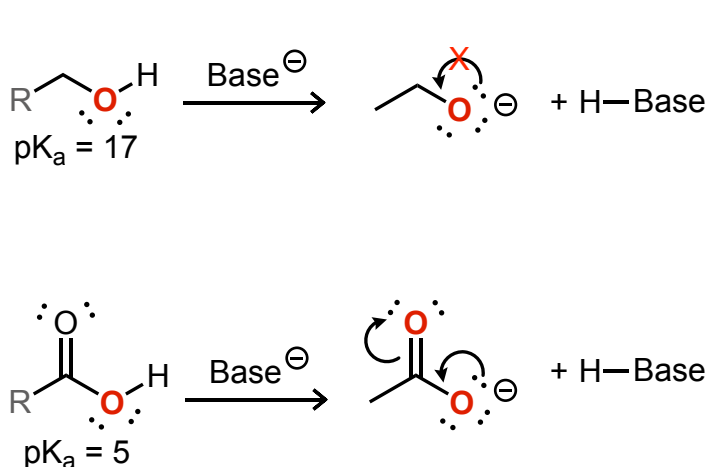
1. Polarizability: "spreading out" electron density on a larger atom can be a stabilizing effect



Rule of thumb when considering acidity:
The more stable the conjugate base, the stronger the parent acid

Iodide, being larger, is able to stabilize its electrons (since it is more polarizable) better than fluoride can. Thus, iodide anion is more stable than fluoride, and HI is $\sim 1.0 \times 10^{13}$ times more acidic than HF!

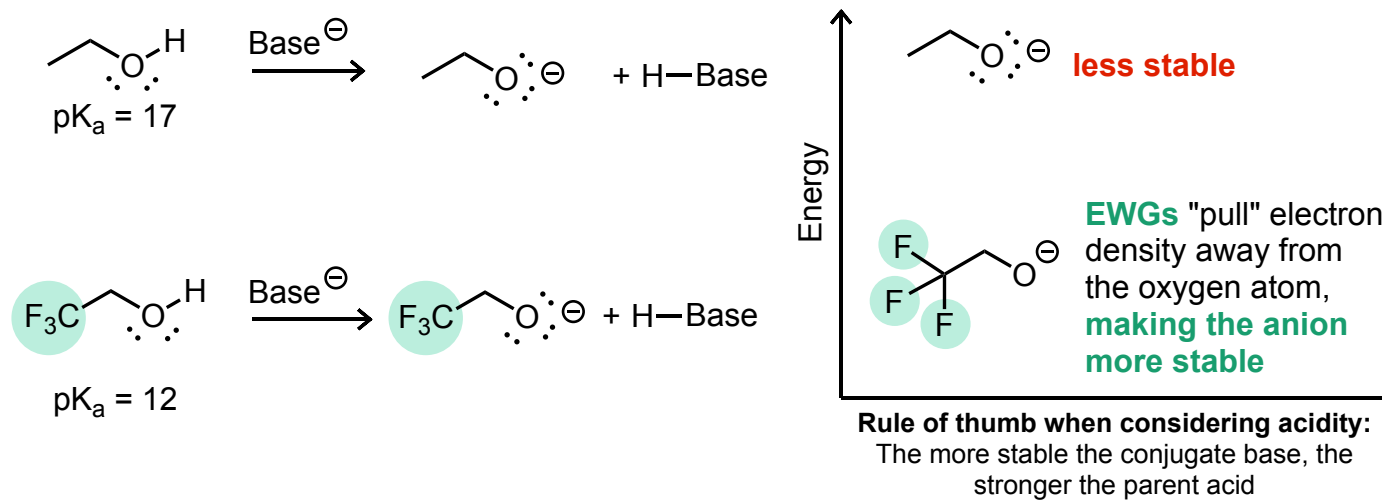
2. Resonance: spreading out charge through resonance delocalization is typically a stabilizing effect



Rule of thumb when considering acidity:
The more stable the conjugate base, the stronger the parent acid

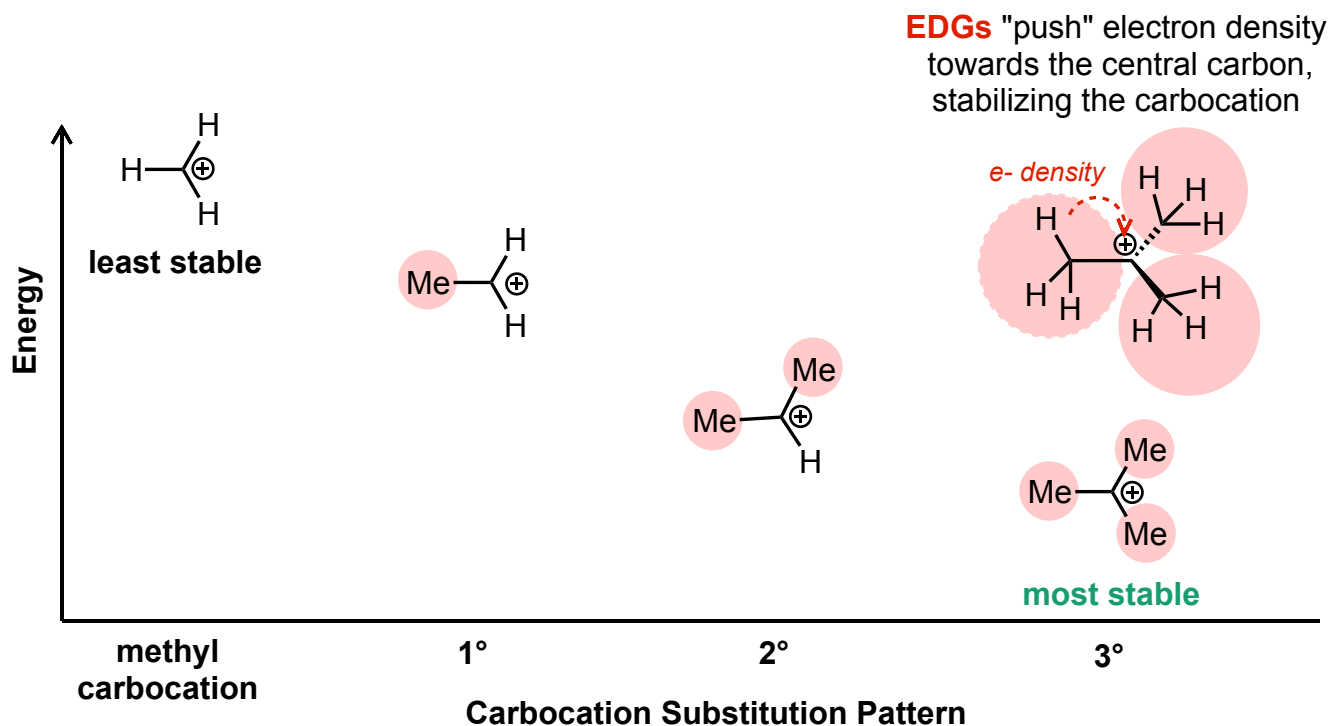
In a carboxylate ion, the electrons are delocalized and spread out over both oxygen atoms **through resonance**. Thus, the carboxylate ion is more stable than an alkoxide ion, and a carboxylic acid is approximately 1.0×10^{12} times more acidic than an alcohol

3. Electron Withdrawing Groups (EWG): the presence of an **EWG** (for example, an electronegative halogen) can stabilize an anionic molecule



In trifluoroethanol, the electronegative fluorine atoms (**EWGs**) help stabilize the negative anion compared to the anion in ethoxide. Thus, trifluoroethanol is approximately 1.0×10^5 times more acidic than ethanol!

4. Electron Donating Groups (EDG): the presence of an **EDG** (for example, an alkyl group) can stabilize carbocations, which are inherently electron-deficient



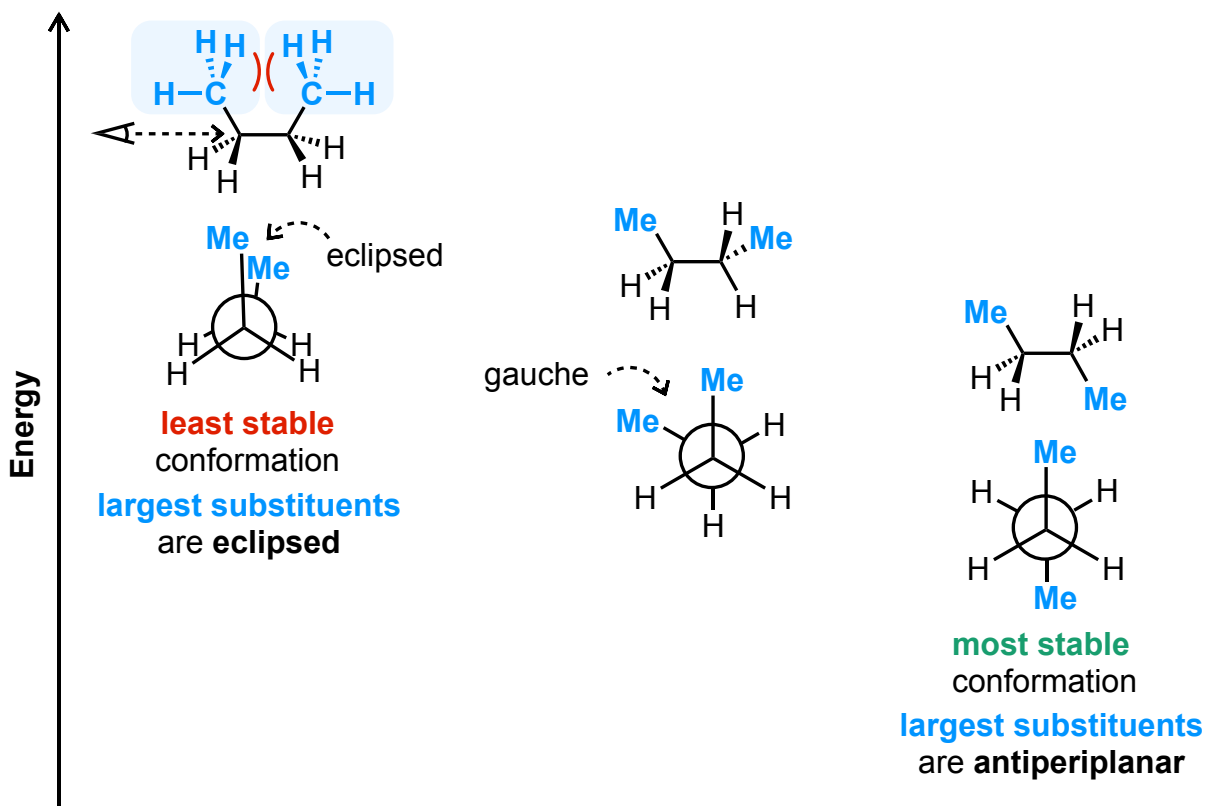
A more substituted carbocation is more stable due to electron density provided by nearby **EDGs**

Sterics

concerned with the "location" and **size of atoms** and **functional groups**

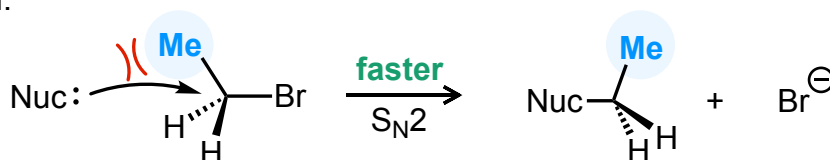
1. Conformation (Intramolecular Steric Clashes)

To stabilize a molecule's 3D "shape", single bonds rotate to position **large groups** further apart (for example, in butane)

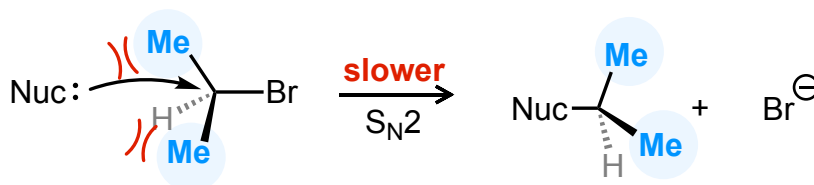


Steric Repulsion (Intermolecular Steric Clashes)

The ability of molecules to effectively interact and access each other can influence the rate of a chemical reaction.



A nucleophile has little difficulty accessing a sterically unhindered electrophile (for example, a primary bromide), resulting in a faster $\text{S}_{\text{N}}2$ reaction



A nucleophile has difficulty accessing a more sterically hindered electrophile, resulting in a slower $\text{S}_{\text{N}}2$ reaction

Alkene Stability based on Substitution Pattern

While sterics and electronics (stereoelectronics) impact the stability of an alkene, **increasing the number of non-hydrogen substituents (R) on the alkene increases its thermodynamic stability**

Note: "R" is indicating a non-hydrogen group

