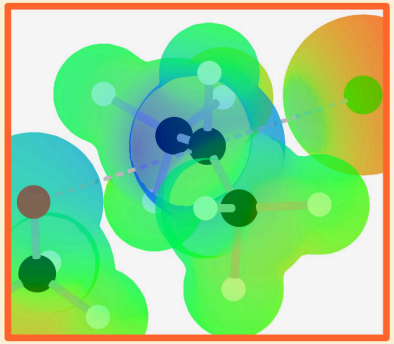
HIGHLIGHTS

- S_N1 mechanism
  - Unimolecular, rate depends on substrate
- S_N2 mechanism
  - Bimolecular, rate depends on substrate & nucleophile
- Factors influencing mechanism
  - Substrate structure (carbocation)
  - Substrate structure (steric bulk)
  - Substrate structure (leaving group)
  - Nucleophile
  - Solvent



The two common mechanisms for substitution at a saturated carbon atom are S_N1 and S_N2 substitution. These differ by the number of molecules in the rate determining step. The rate of an S_N1 substitution is determined the substrate only. The reaction is first order and occurs with two discrete steps; dissociation of the leaving group, and addition of the nucleophile. The reaction often occurs with lose of stereochemical information. The S_N2 substitution is bimolecular with both the substrate and nucleophile influencing the rate. It is a single step process with all bonds being made and broken at the same time. The reaction occurs with inversion of stereochemistry. The most important factor for determining whether a reaction is S_N1 or S_N2 is whether the stability of the carbocation. Other factors, such as solvent, can play a role but they tend to be less important.

CHEMISTRY CLASSICS

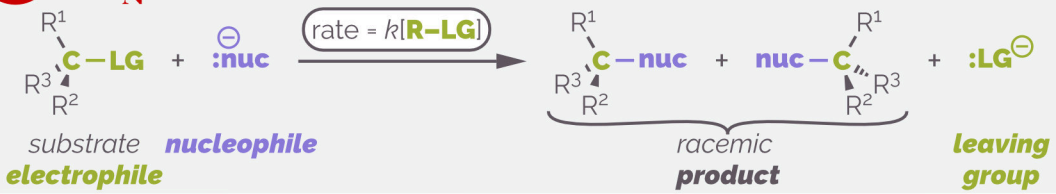
SUBSTITUTION REACTIONS

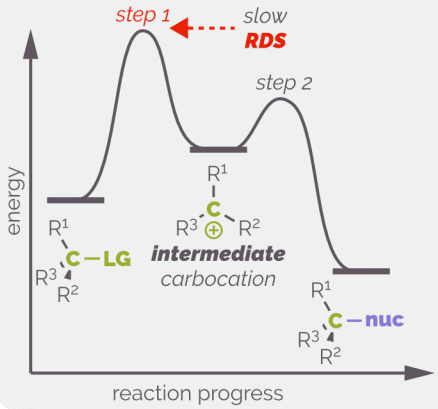
S_N1 AND S_N2 MECHANISMS

Substitution at a saturated carbon

Making MOLECULES www.makingmolecules.com

1. S_N1 substitution

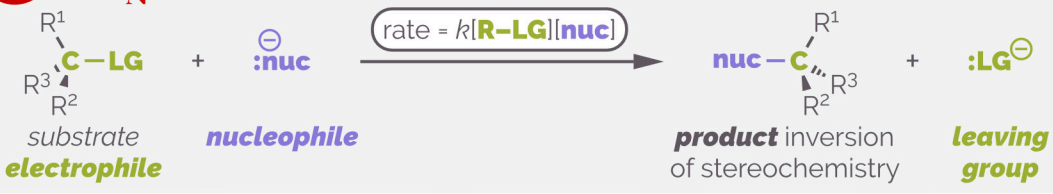


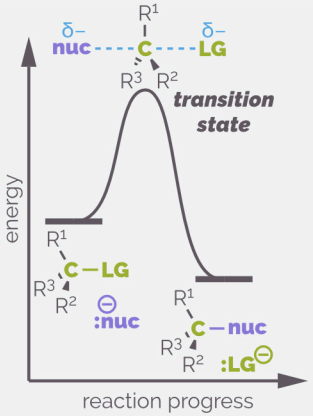


step 1: ionization

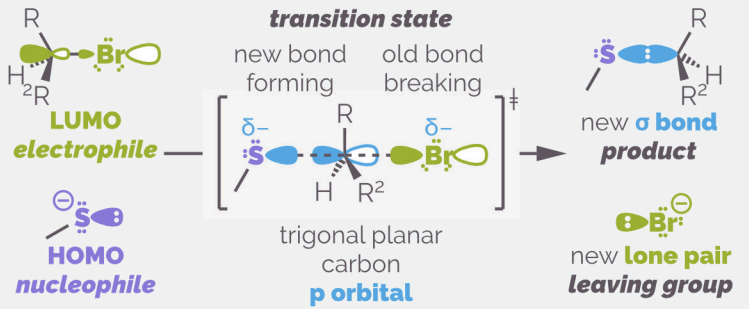
step 2: nucleophilic addition

2. S_N2 substitution





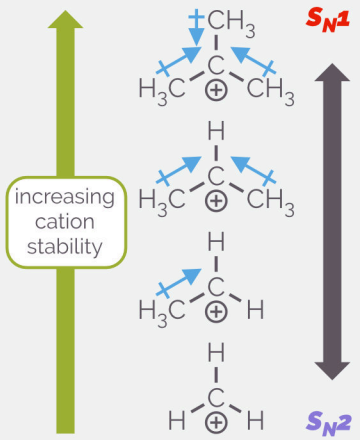
single step



3. Factors influencing mechanism of substitution

A. Substrate structure

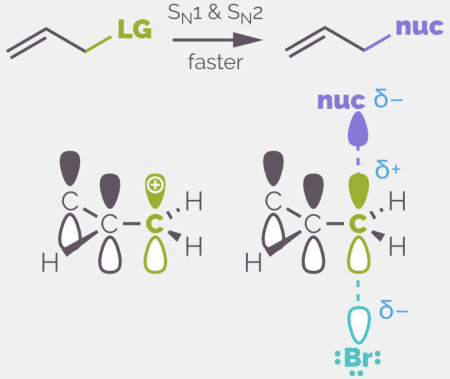
Cation stability favors S_N1



factors destablizing carbocaton (α-carbonyl) disfavor S_N1

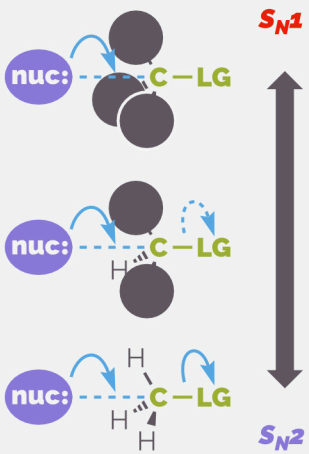
B. Substrate structure

Delocalization enhances both



C. Substrate structure

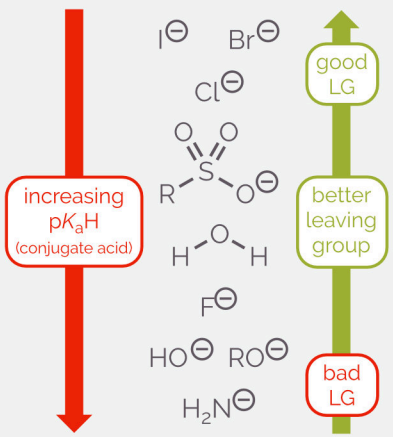
Sterics bulk favors S_N1



bulk disfavors S_N2 transition state
Strain released in S_N1 intermediate

D. Substrate structure

Leaving group enhances both



pK_aH gives trend useful at UG
but not true (sulfonates better than list suggests)

E. Nucleophile

*Strong **nuc** favors S_N2*
*Weak **nuc** disfavors S_N2*

Strong: I^-, RS^-, RO^-, NC^-, N_3^-

Moderate: RSR, NH_3, Cl^-, AcO^-

Weak: F^-, ROH, H_2O

F. Solvent

Polar protic favors S_N1

Polar aprotic favors S_N2