



Substitution and Elimination Reference Guide

Components	S _N 1	S _N 2
How many reaction steps?	2 steps: Leaving group leaves, creating a carbocation and is then attacked by a nucleophile.	1 step: Backside attack by a nucleophile causes leaving group to leave.
Reaction Rate	Rate=k[substrate] Unimolecular reaction	Rate=k[nucleophile][substrate] Bimolecular reaction
Stability Trend	Benzylic>allylic> 3° > 2° > 1° Stability of the carbocation is important	Benzylic>allylic>methyl> 1° > 2° > 3° Never occurs on 4°; considers steric hindrance
Solvent Type	Polar protic ex: H ₂ O, alcohols	Polar aprotic ex: acetone, DMSO, DMF, DME
Nucleophile Strength	Weak nucleophile Delocalized charge, small, etc. ex: H ₂ O, alcohols	Strong nucleophile due to: <ul style="list-style-type: none">• Nucleophilicity: increases with decreasing electronegativity; decreases with resonance, inductive effects, and sterics.• Polarizability: directly related to size of atom. I⁻>Br⁻>Cl⁻ ex: RS ⁻ , CH ₃ S ⁻ , CN ⁻ , N ₃ ⁻ , RCO ₂ ⁻ Localized, negative charge
Special Considerations	Creation of racemic product due to low preference of nucleophile on which side to attack. Utilizes Hydride or methyl shifts	Inversion of configuration due to backside attack of nucleophile

Components	E ₁	E ₂
How many reaction steps?	2 steps: Leaving group leaves, creating a carbocation and then loses a proton, forming a double bond.	1 step: Base removes a proton and leaving group leaves, forming a double bond.
Reaction Rate	Rate=k[substrate] Unimolecular reaction	Rate=k[base][substrate] Bimolecular reaction
Stability Trend	3° > 2° > 1° Stability of the carbocation is important	3° > 2° > 1°
Solvent Type	Polar protic ex: H ₂ O, alcohols	Polar aprotic ex: acetone, DMSO, DMF, DME
Base Strength	Base strength is not important	Strong base is preferred -OH, -OR, -NH ₂ , -CH ₃ , H ⁻
Special Considerations	Is not stereospecific, but has a preference for Zaitsev products . Utilizes hydride or methyl shifts Watch for dehydration of alcohols	Is stereospecific : There must be an H anticoplanar to the leaving group. Yields Zaitsev products unless a sterically hindered base is used → Hoffman product favored . ex:t-butoxide, LDA

Source: Wade, L. G. (2013). Organic chemistry. Prentice Hall.