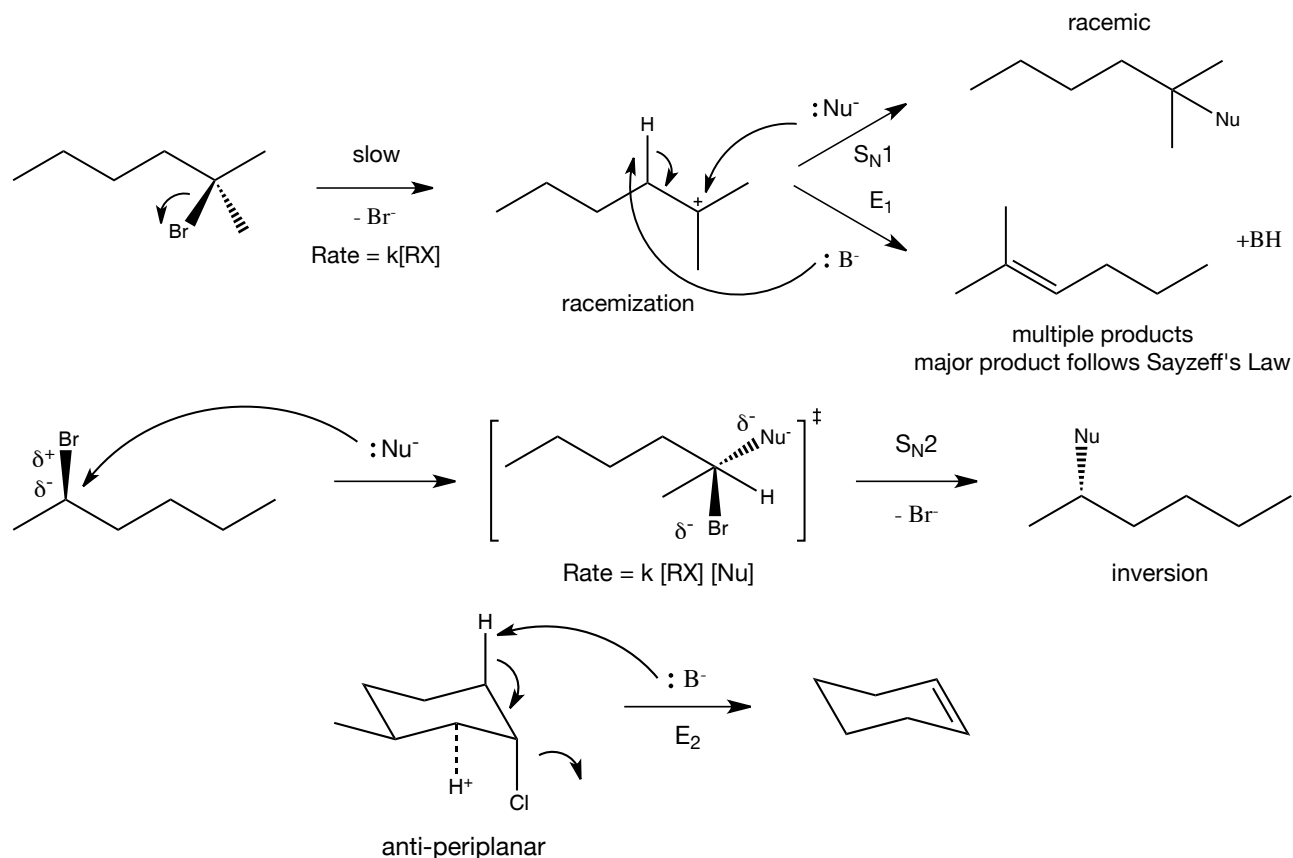


Mechanisms

S_N1 , S_N2 , E_1 , E_2

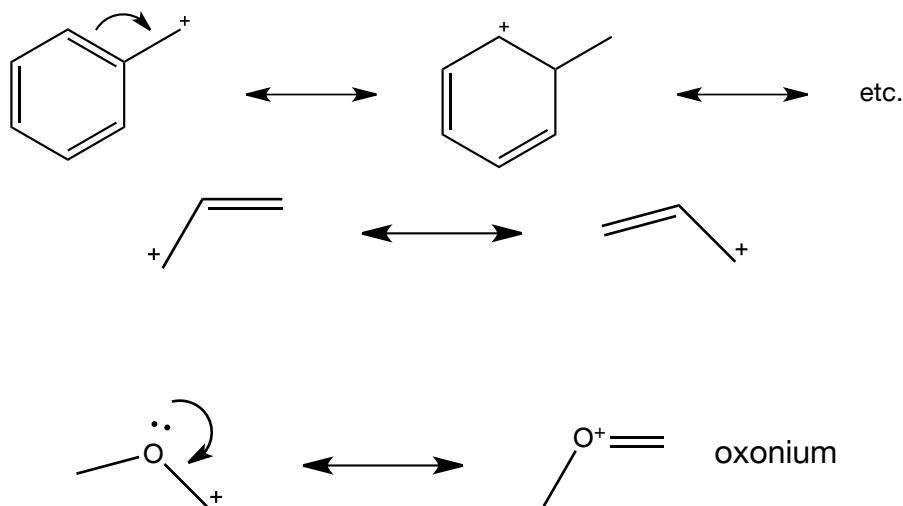


Affecting Factors:

This builds on the factors presented in Chapter 4.

Steric hindrance greatly slows S_N2 by shielding δ^+C from nucleophilic attack. E_2 may also be slowed if bulky bases are used.

Carbocation stability increases rate of E_1 and S_N1 by decreasing E_a leading to the carbocation intermediate. Carbocations can be stabilized by inductive donation of s-orbital e^- by adjacent R-groups, or by resonance delocalization to spread the positive charge on more atoms.



Nucleophilicity chooses S_N2 over S_N1 , while **basicity** is important in E_2 . The greater the charge

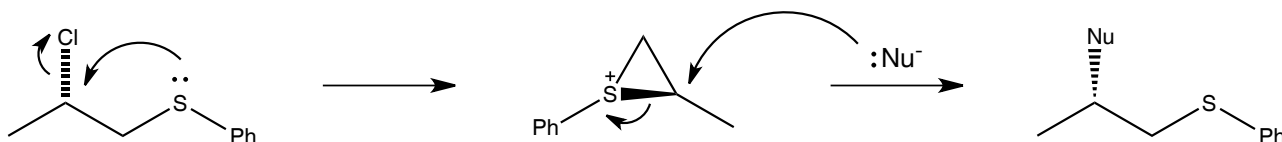
density (-ve), the stronger the nucleophile, but in polar protic solvents, nucleophilicity decreases in the order $\text{HS}^- > \text{HO}^-$ and $\text{I}^- > \text{Br}^- > \text{Cl}^- > \text{F}^-$. as the smaller anions are more strongly solvated (not the case in polar aprotic solvents). Nucleophilicity parallels basicity, except where a bulky base is too bulky to be a good Nu^- . Note that nucleophilicity measures how good a lone pair is in adding to an electrophilic centre (like carbon), while basicity is how good that species is in donating a lone pair to H^+ and hence deprotonating another species.

The stability of the **leaving group** increases the rate of $\text{S}_{\text{N}}2$, and favours $\text{S}_{\text{N}}1$ over E_1 . The greater the ability to stabilize the negative charge, i.e. the larger the size (more impt.) or the more electronegative the group, the better it is as a leaving group. Good leaving groups: X^- , H_2O . Poor leaving groups: OH^- , F^- , NH_2^- , ...

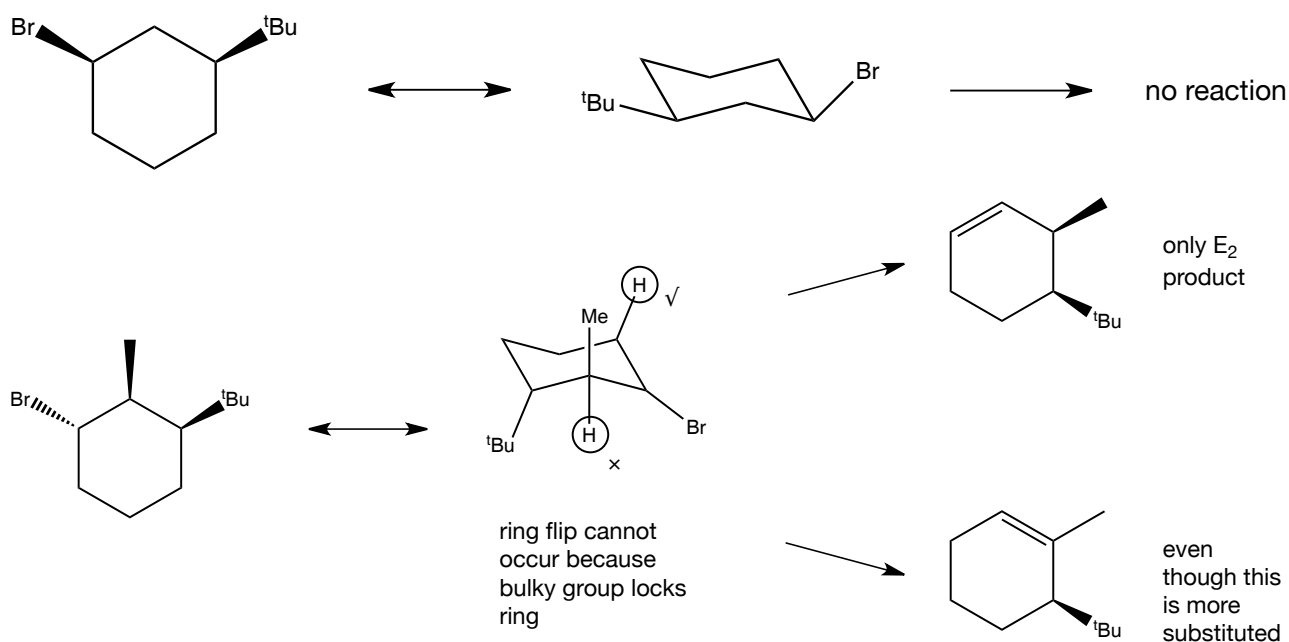
Polar protic solvents can solvate both cations and anions, including via hydrogen bonds. Polar aprotic ones lack S^+H to solvate anions, not forming solvent cages around Nu^- , hence increasing the charge density and reactivity of the Nu^- , increasing rate of $\text{S}_{\text{N}}2$ reactions. Generally, polar solvents (stabilizes cations) are sufficient for $\text{S}_{\text{N}}1/\text{E}_1$.

Temperature, if increased, favours, E_1 and E_2 as entropy increases the elimination reactions (more molecules produced).

Neighbouring groups may participate in and accelerate $\text{S}_{\text{N}}2$, the rule being that intramolecular reactions are faster than intermolecular reactions. This “double $\text{S}_{\text{N}}2$ ” leads to retention of configuration instead of inversion of configuration as with a single $\text{S}_{\text{N}}2$.



Multiple products may be possible for E_2 , favouring the more substituted products. It is first necessary to consider the possibility of E_2 , which depends on whether the H and leaving group are anti-periplanar/trans-diaxial. It is a stereochemical requirement of E_2 reactions for the H eliminated and the leaving group to be anti-periplanar (i.e. on opposite sides). The anti-periplanar elimination occurs even if the product does not follow Sayzeff's Law. The full explanation for the anti-periplanar requirement requires an understanding of MO theory which we should not concern ourselves with at this stage (for the curious: the reason is electron donation into the anti-bonding orbital of the C-leaving group).



Choosing the right reaction conditions often allows selection of the desired products.

Conditions favouring	S_N1	E_1	S_N2	E_2
Primary	×	×	<ul style="list-style-type: none"> • Strong Nu^-. • Polar aprotics. 	<ul style="list-style-type: none"> • Strong base.
Secondary	<ul style="list-style-type: none"> • Steric • Stable C^+. • Moderate Nu^-. • Weak base. • Polar protics. • Good LG. 	<ul style="list-style-type: none"> • Steric. • Stable C^+. • Poor Nu^-. • Moderate base. • Polar protics. • Good LG. 	<ul style="list-style-type: none"> • No steric. • No stable C^+. • Good Nu^-. • Weak base. • Polar aprotics. • Moderate LG. 	<ul style="list-style-type: none"> • Strong base. • Moderate LG.
Tertiary	<ul style="list-style-type: none"> • Better Nu^-. • No base. 	<ul style="list-style-type: none"> • Poor Nu^-. • Base present. • E_1 and E_2 favoured by temperature. 	<ul style="list-style-type: none"> • Anti-periplanar configuration required. 	<ul style="list-style-type: none"> • Strong base. • Favoured by anti periplanar configuration. • E_1 and E_2 favoured by temperature.