Class 12 Organic Chemistry — Reaction Mechanisms Quick Reference

A companion download to the Cogniks blog post: "NCERT Class 12 Chemistry: Organic Chemistry Reaction Mechanisms Made Simple" — cogniks.com

1. Nucleophilic Substitution at Saturated Carbon (Haloalkanes & Haloarenes)

Feature	S_N1	S_N2
Number of steps	Two steps	One step (concerted)
Rate-determining step	Formation of carbocation (bond breaking)	Simultaneous bond breaking + bond making
Rate law	Rate = k[R-X]	Rate = k[R-X][Nu^-]
Preferred substrate	3° (tertiary) halides — stable carbocation	1° (primary) halides — least steric hindrance
Stereochemistry	Racemization (attack from both faces of planar carbocation)	Walden inversion (backside attack only)
Typical conditions	Polar protic solvent, weak nucleophile	Polar aprotic solvent, strong nucleophile

Quick recall: "Tertiary reacts by S_N1, primary reacts by S_N2" — secondary halides can go either way depending on solvent and nucleophile strength.

2. Elimination at Saturated Carbon (Alcohols & Haloalkanes)

Feature	E1	E2
Number of steps	Two steps (via carbocation)	One step (concerted)
Base/conditions	Weak base, often competes with S_N1	Strong, bulky base (e.g. alc. KOH)
Preferred substrate	3° substrates	1°/2°/3° — favoured with bulky base
Geometry requirement	None strict	Anti-periplanar H and leaving group

3. Nucleophilic Addition at the Carbonyl Carbon (Aldehydes & Ketones)

The carbonyl carbon (C=O) is electrophilic because oxygen pulls electron density toward itself. A nucleophile attacks this carbon, pushing the C=O π-electrons onto oxygen to form an alkoxide intermediate, which is then protonated to give the final product.

Step	What happens
Step 1	Nucleophile (Nu^-) attacks the electrophilic carbonyl carbon
Step 2	C=O π-bond breaks; electrons move to oxygen, forming an alkoxide ion (tetrahedral intermediate)
Step 3	Alkoxide is protonated (by H_3O^+ or H_2O) to give the neutral addition product

Why aldehydes react faster than ketones: fewer/smaller alkyl groups around the carbonyl carbon mean less steric hindrance to the incoming nucleophile, and alkyl groups also push electron density onto the carbonyl carbon (+I effect), making it less electrophilic in ketones than in aldehydes.