S_N1 and S_N2 Reactions

An organic chemistry workshop for the ARC

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This workshop will address:

- SN2 reactions
  - Break it down: what does it mean?
  - Rundown
  - Notes
- SN1 reactions
  - Unimolecular: the main difference
  - Step-by-step
- Review: SN1 vs SN2
- Resources

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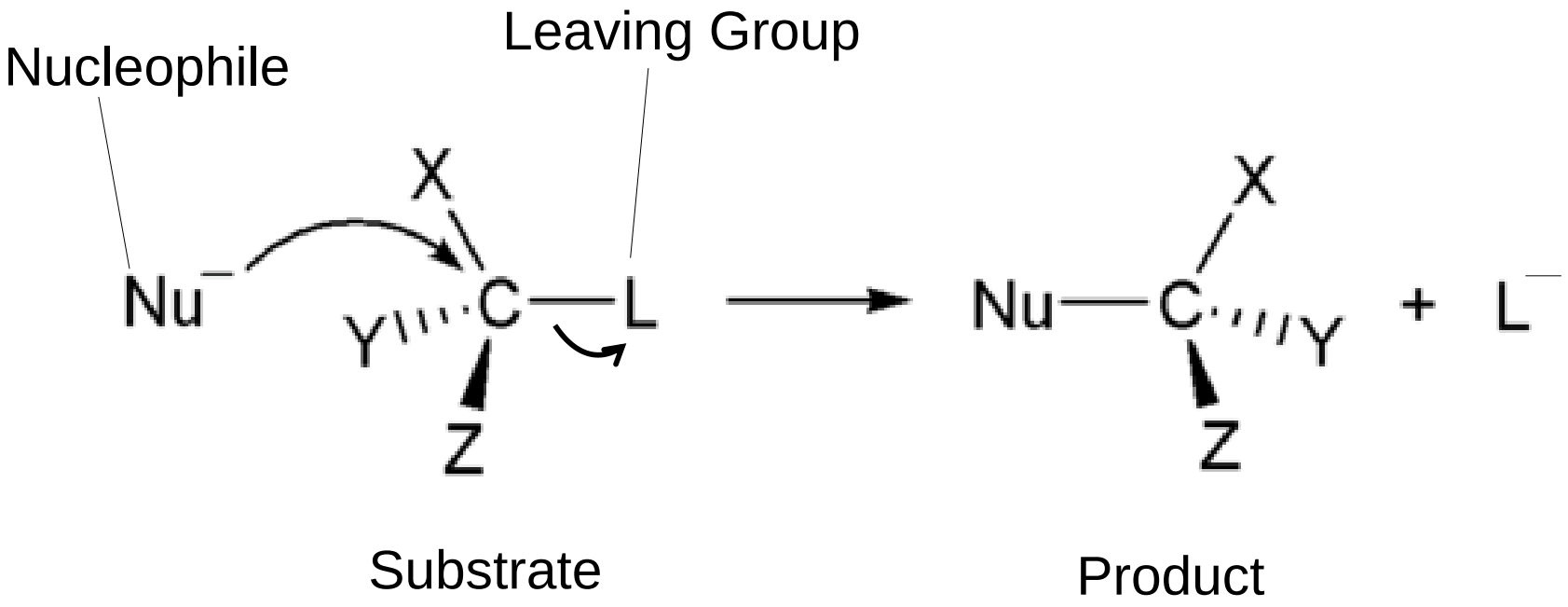
The S_N2 Reaction



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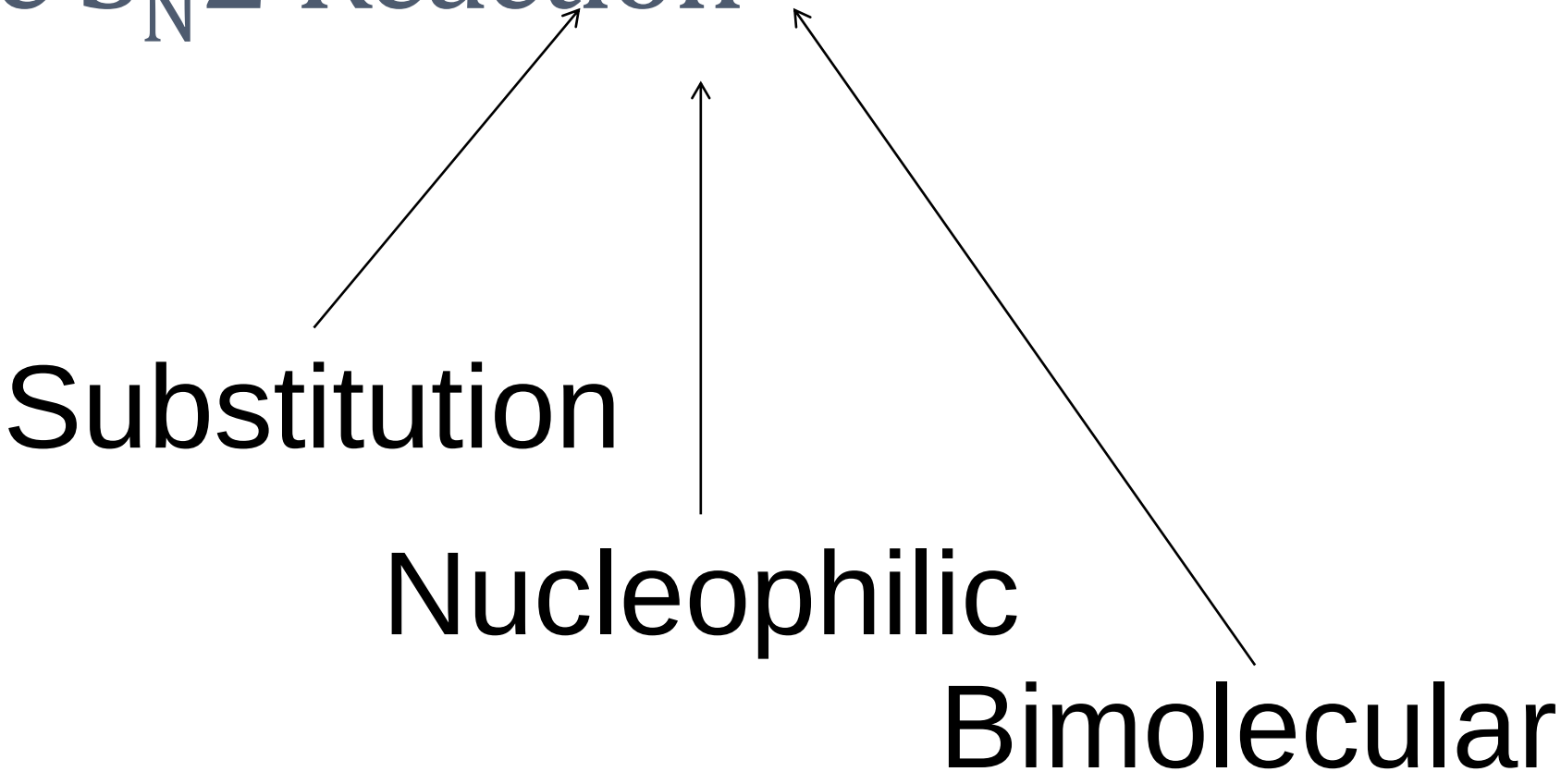
The S_N2 Reaction



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The S_N2 Reaction

Substitution: this reaction involves a *substitution* of players – two reactants produce two products, in which some things have been switched around:

- Tip: think of this if you get elimination (E1 and E2) reactions mixed up with substitution (SN1 and SN2) reactions.

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The S_N2 Reaction

Nucleophilic: these reactions involve a nucleophile ($Nuc:^-$) replacing a leaving group.

- Nucleophiles attack the substrate, donating an electron pair to the new bond, and replacing the leaving group (a substitution).

- Tip: Remember the role of a nucleophile by its Greek roots: **Nucleo**-(nucleus)-**phile**-(lover) – it is attracted to the nucleus, which is positively charged! Nucleophiles are therefore negatively charged or strongly δ-.

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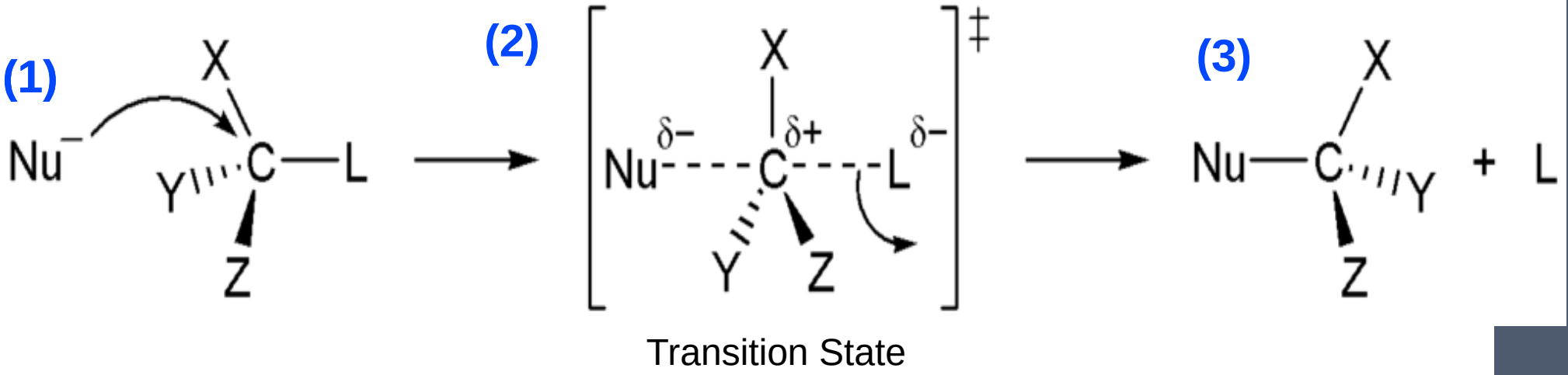
The S_N2 Reaction

Bimolecular: A *bi*molecular reaction is one whose rate depends on the concentrations of *two* of its reactants.

- SN2 reactions happen in one step – the nucleophile attacks the substrate as the leaving group leaves the substrate.
- Tip: Recall that the rate of a reaction depends on the slowest step. In bimolecular reactions, therefore, the slow step involves two reactants. For SN2 reactions, there are only two reactants; this means that the slow step is the *only* step.

The S_N2 Reaction



SN2 summary:

(1) Nucleophile back-side attacks the δ+ carbon center.

(2) Transition state forms in which nucleophile is forming bo

(3) The leaving group leaves, forming the final product.

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The S_N2 Reaction

Notes:

- In the SN2 reaction, the nucleophile attacks from the most δ+ region
- This back-side attack causes an *inversion* (study the previous slide):
- The nucleophile must be able to reach the δ+ carbon center that it is

- Tip: see chapter 6 of your textbook to learn what makes a good nucleophile o

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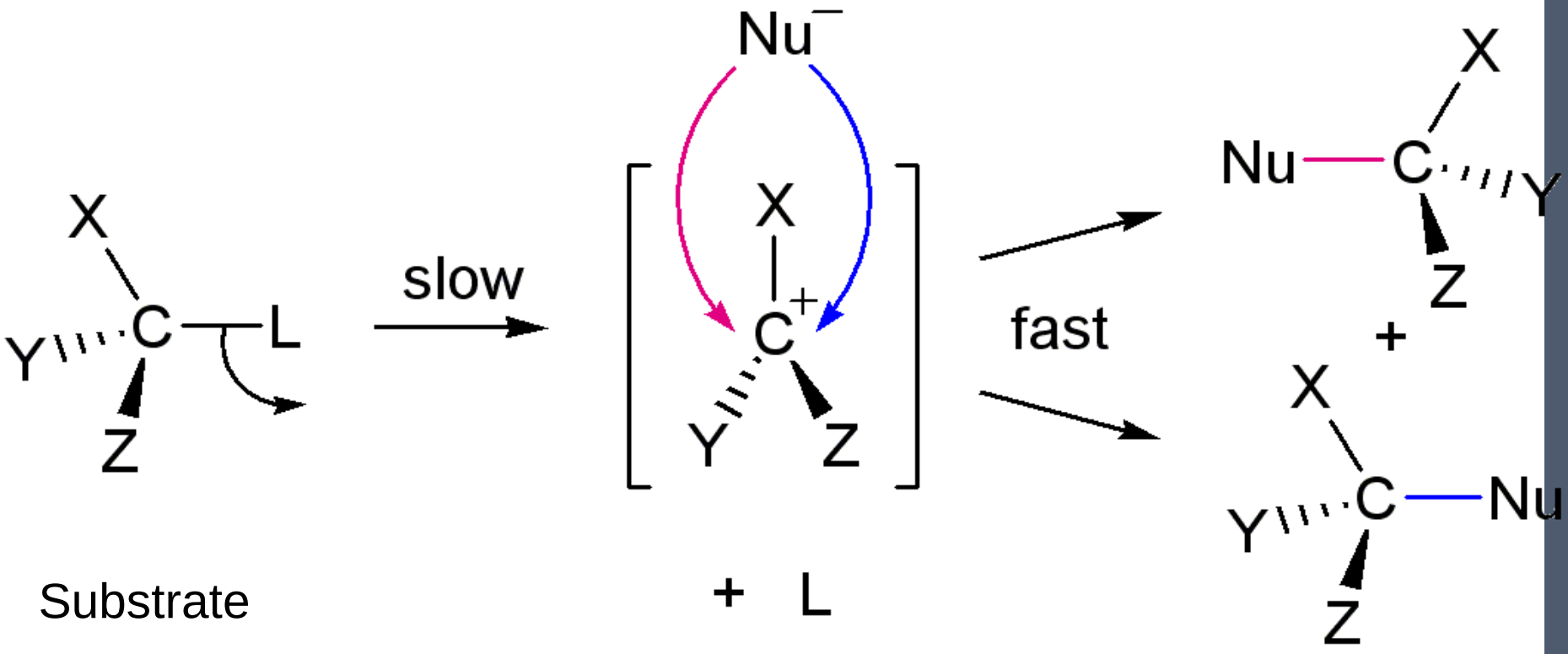
The S_N1 Reaction



Substrate

Carbocation Intermediate

Products

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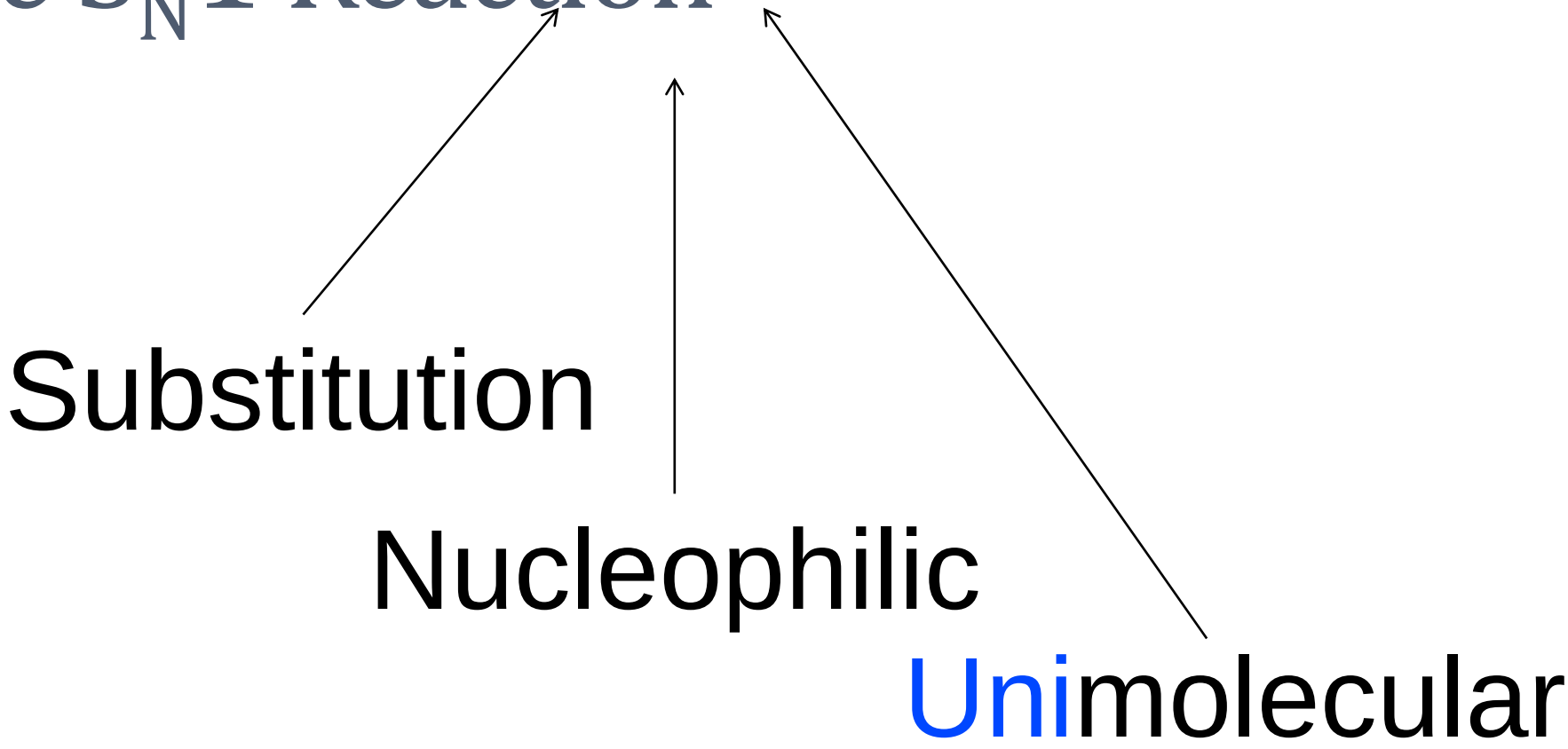
The S_N1 Reaction



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The S_N1 Reaction

SN1 reactions are nucleophilic substitutions, involving a nucleophile replacing a leaving group (just like SN2).

However: SN1 reactions are **unimolecular:** the rate of this reaction depends only on the concentration of *one reactant.*

- SN1 reactions happen in two steps:

  1. The leaving group leaves, and the substrate forms a *carbocation intermediate*.
  2. The nucleophile attacks the carbocation, forming the product.

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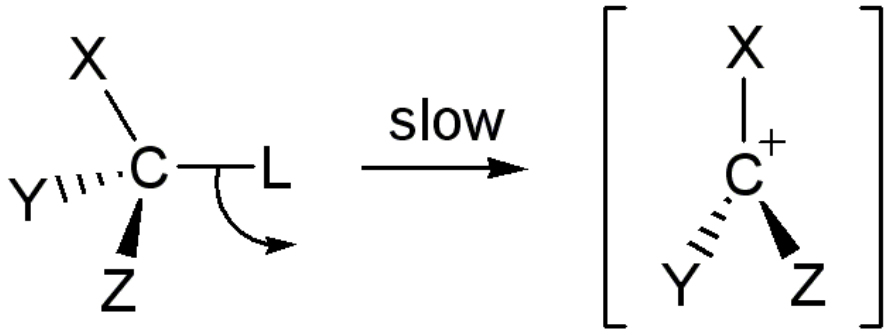
The S_N1 Reaction

1. The Slow Step:



First step of the SN1 reaction:

The leaving group leaves, and the substrate carbon now only has thre

- Carbocations are most stable when there are more atoms to distribute
- Carbocation stability:

$$3^o > 2^o >> 1^o$$

- Tip: study the difference between reaction intermediates and transition state

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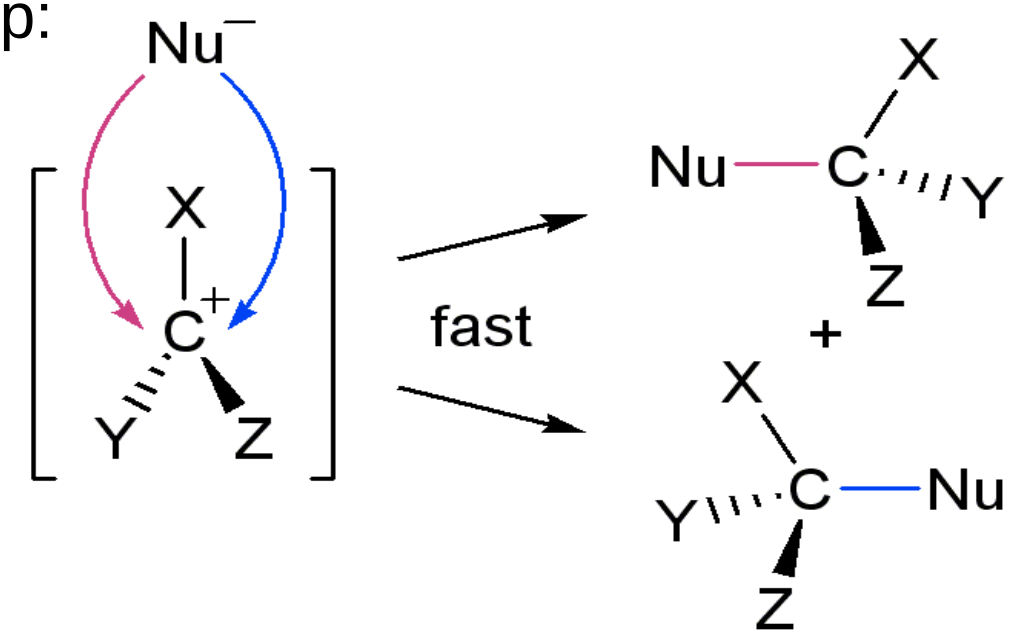
The S_N1 Reaction

2. The Fast Step:



Second step of the SN1 reaction:

The nucleophile attacks the carbocation intermediate, bringing its elec

- The substrate loses any stereospecificity during the carbocation inter

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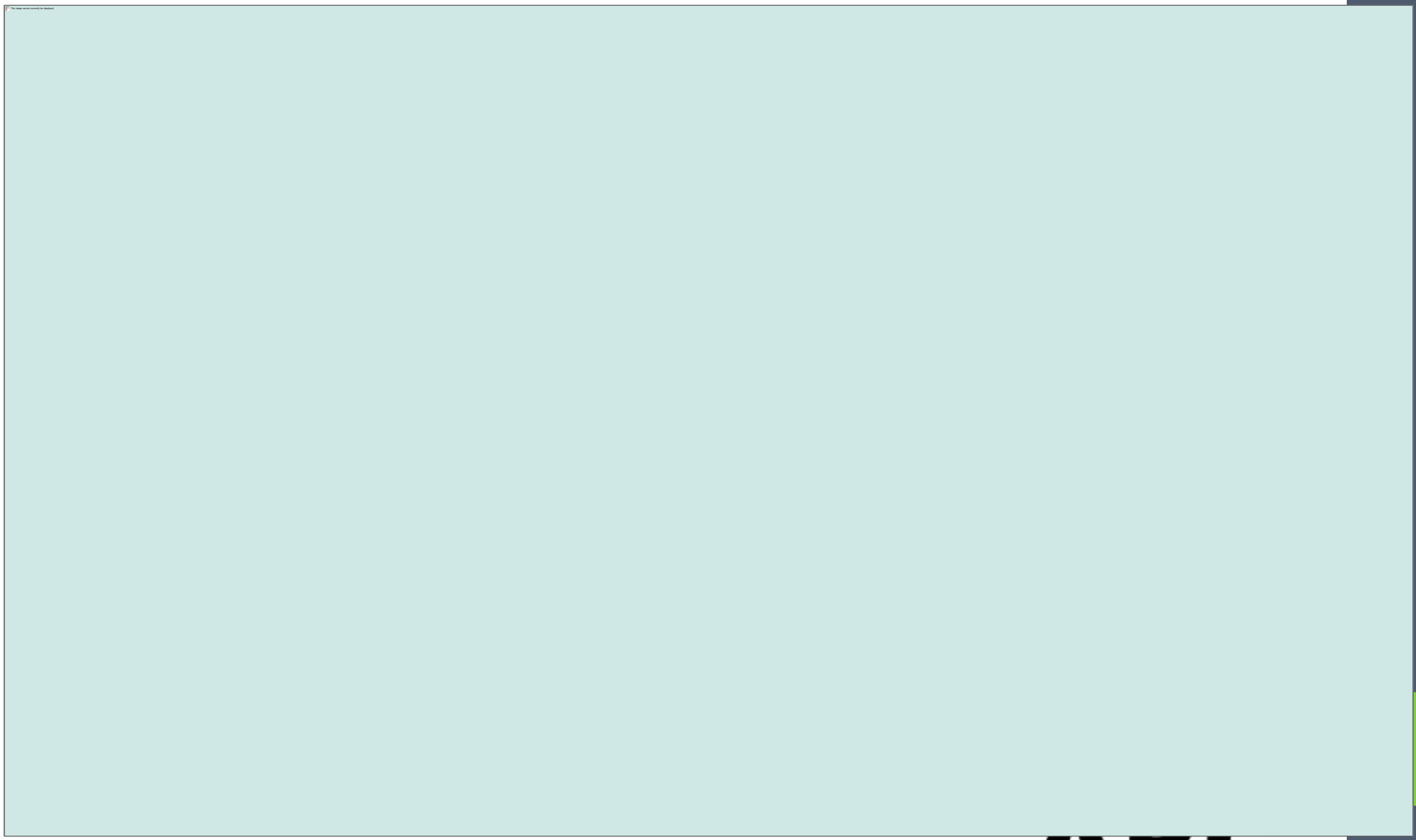
S_N1 vs S_N2 Reactions



Resources

- Chapter 6 of your textbook
- The Khan Academy:
  - SN2 Reactions
  - SN1 Reactions
  - all organic chemistry topics
- Organic Chemistry Portal

- workshop created by Monica

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