



QFL1322 - Reatividade dos Compostos Orgânicos

Aula 6. Eliminação- β

Cassius V. Stevani



Literatura

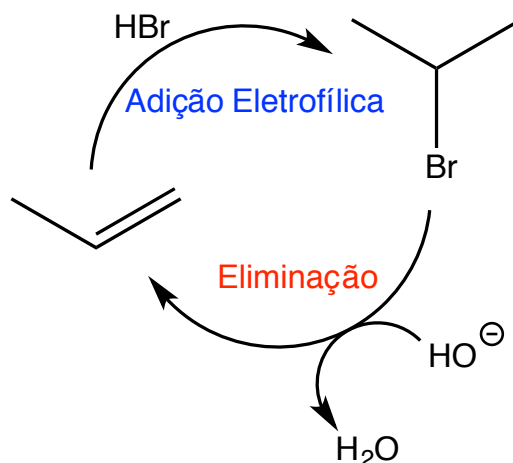
Leitura recomendada. Clayden, Greeves, Warren, Wothers, 2ª edição, cap. 17



Eliminação-β

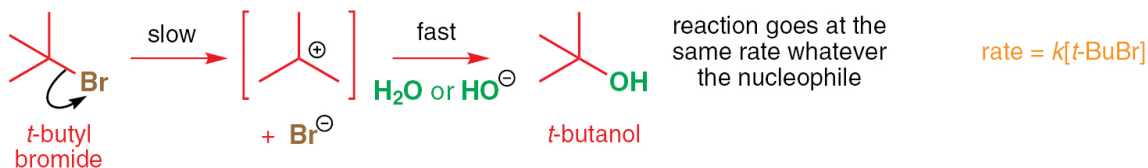
Substituição e eliminação

- Reações de eliminação levam à formação de alkenos. Alcenos, por sua vez, reagem formando produtos que podem sofrer eliminação.

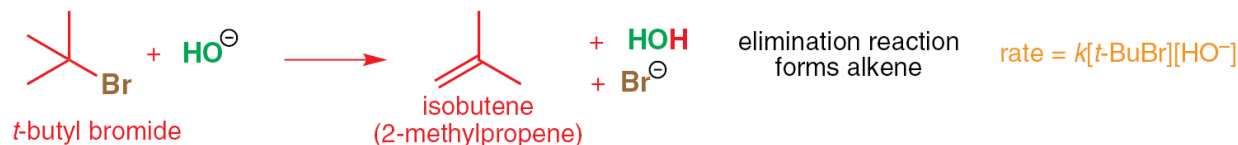


- Os dois tipos mais comuns de mecanismo de eliminação são E1 e E2.

nucleophilic substitution reactions of *t*-BuBr



reaction of *t*-BuBr with concentrated solution of NaOH

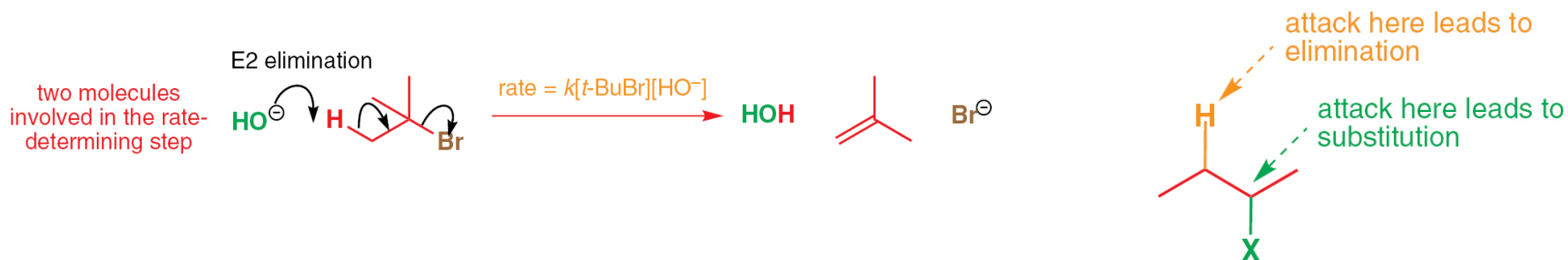




Eliminação-β

Eliminação E2 e E1 | Mecanismos

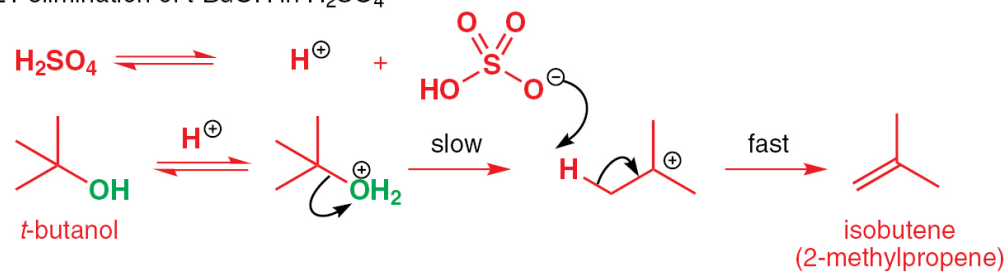
- Eliminação pode ocorrer na presença de base ou ácido.



nucleophilic substitution of *t*-BuOH with HBr



E1 elimination of *t*-BuOH in H_2SO_4



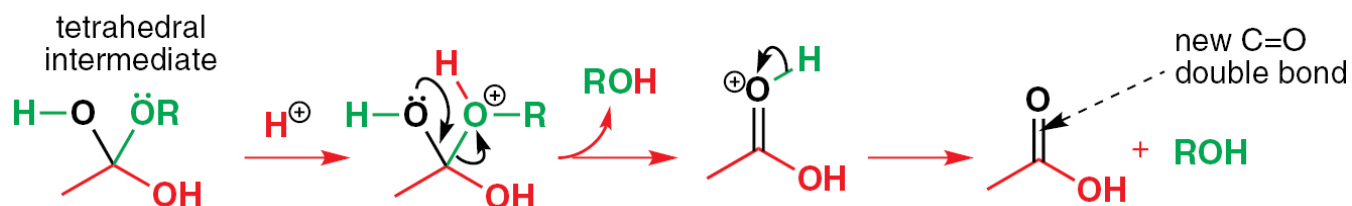


Eliminação-β

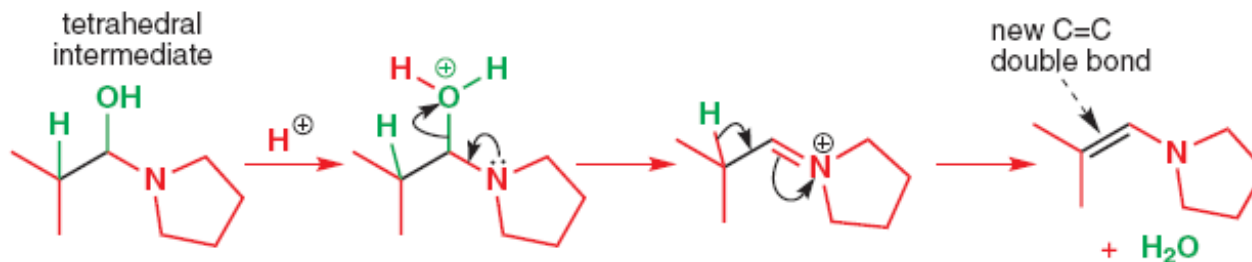
Eliminação E1 | Outros exemplos

- Eliminação E1 pode ocorrer na hidrólise de ésteres e formação de enamina.

E1 elimination of ROH during ester hydrolysis



E1 elimination of H₂O during enamine formation

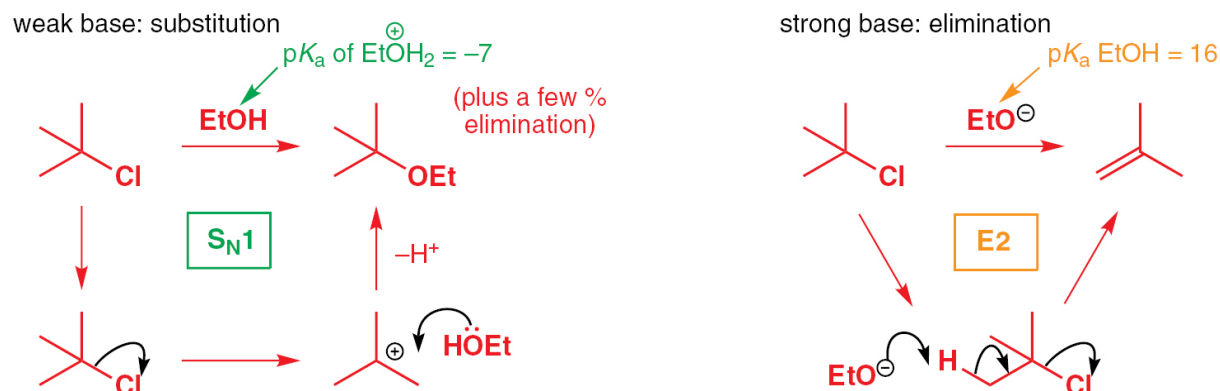




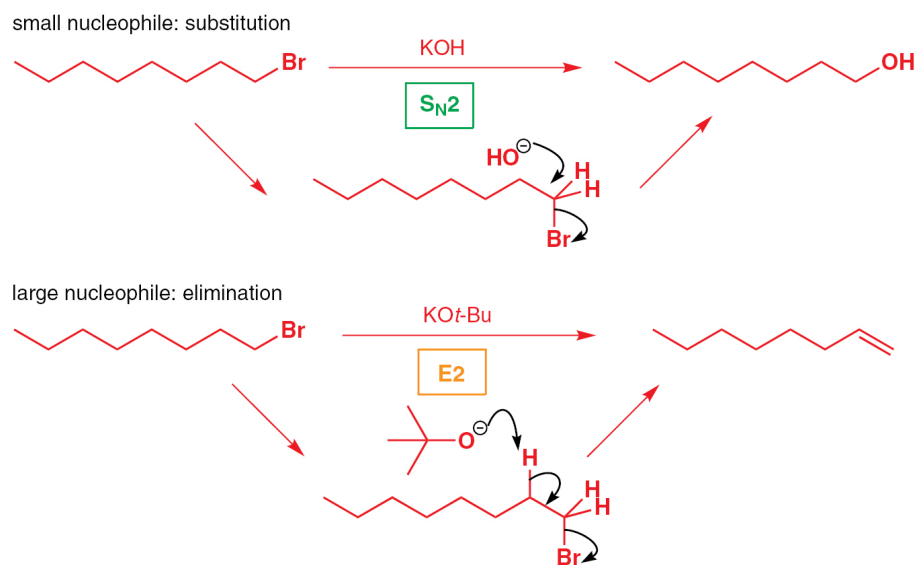
Eliminação-β

Eliminação vs. Substituição | Força e tamanho da base

- A força da base afeta o caminho da reação.



- O tamanho da base afeta o caminho da reação.





Eliminação-β

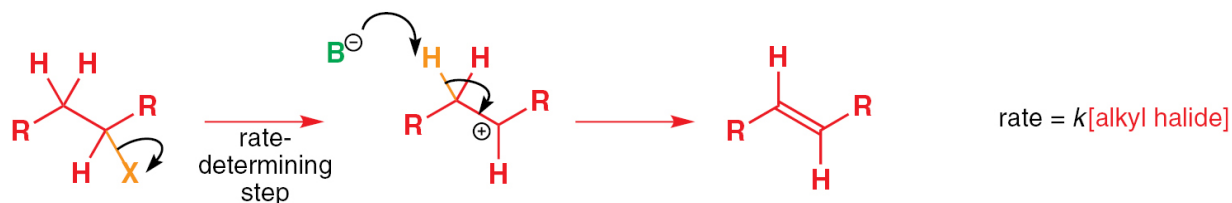
Eliminação vs. Substituição | Temperatura

- Nucleófilos que são bases fortes favorecem eliminação em comparação com substituição.
- Bases volumosas favorecem eliminação.
- Temperaturas altas favorecem E2.

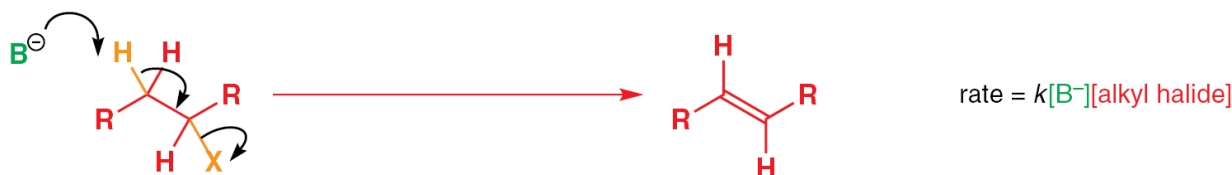
E1 vs. E2

- Mecanismo geral E1.

general mechanism for E1 elimination



general mechanism for E2 elimination



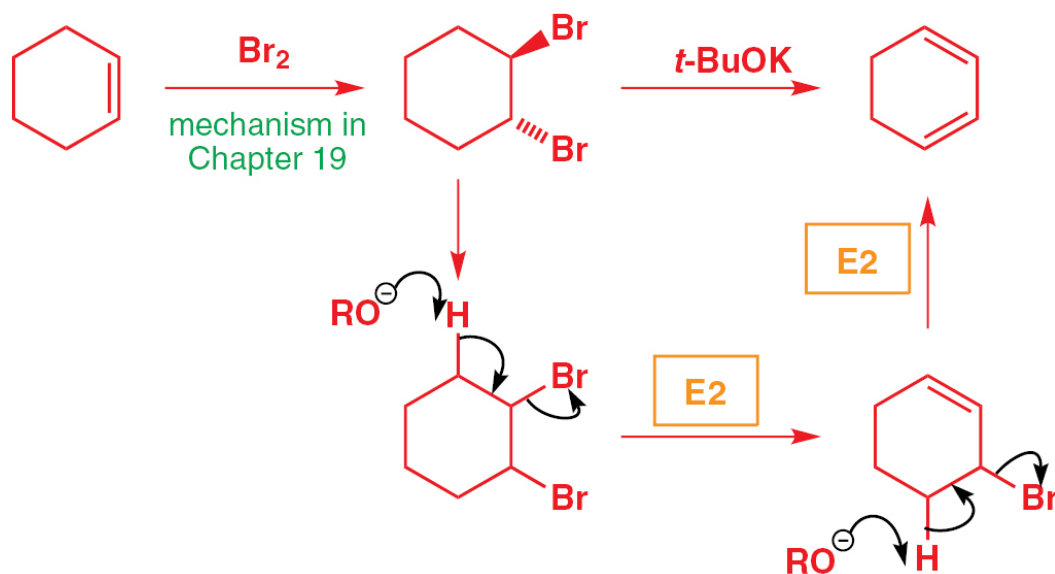
- Inúmeros fatores podem fazer com que uma eliminação ocorra via E1 ou E2.
- Bases volumosas favorecem E2.



Eliminação-β

E2 | Exemplo

synthesis of a diene by a double E2 elimination



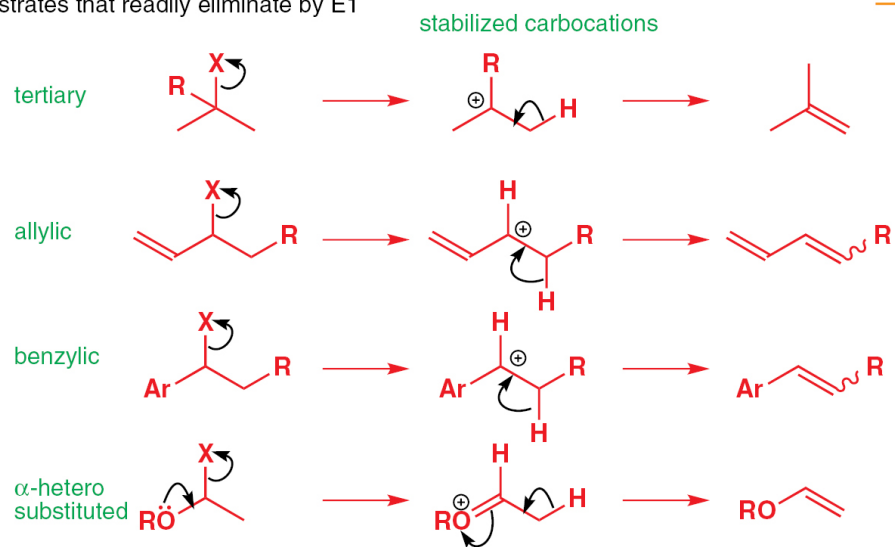


Eliminação-β

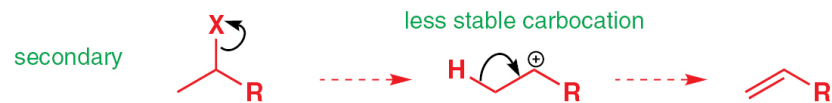
E1 vs. E2

- A estrutura do substrato pode favorecer E1. A formação de um carbocátion estável pode favorecer E1.

substrates that readily eliminate by E1



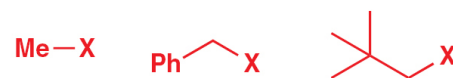
substrates that may eliminate by E1



substrates that never eliminate by E1



substrates that cannot eliminate by either mechanism—no appropriately placed hydrogens

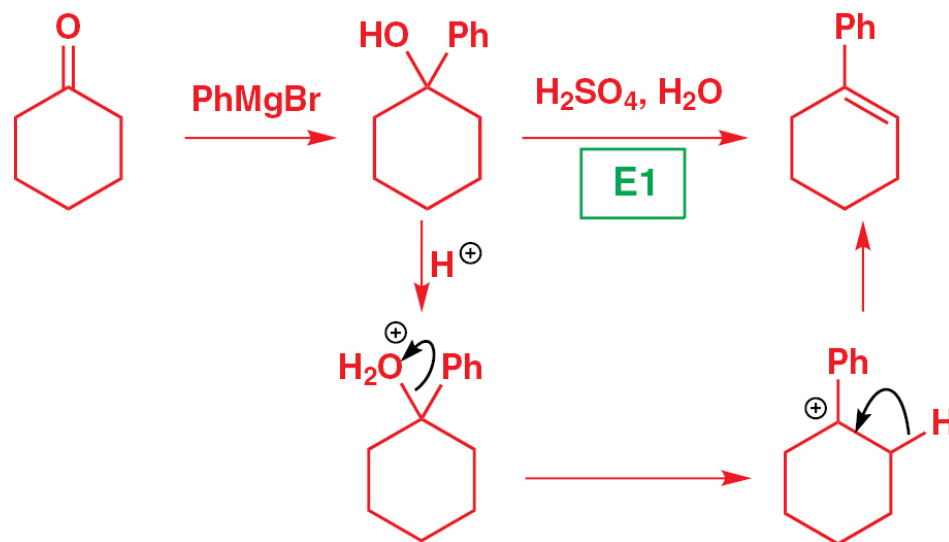


cannot
eliminate
by E2

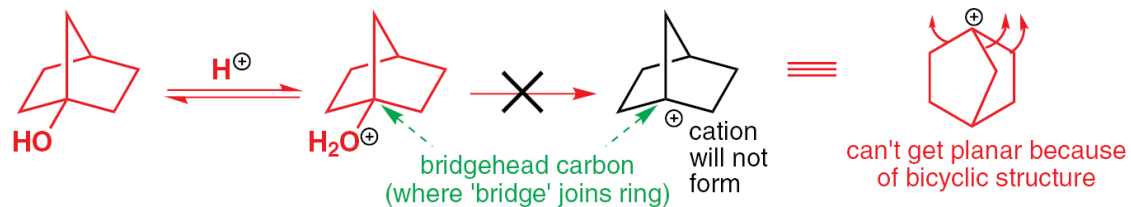


Eliminação-β

E1 | Exemplo



- Cuidado com casos envolvendo estruturas bicíclicas.



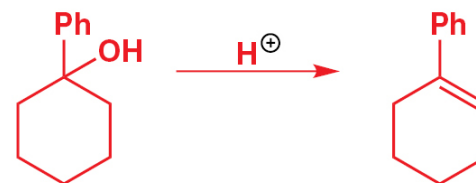
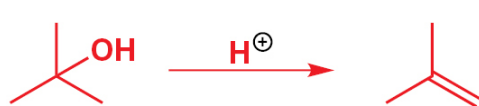


Eliminação-β

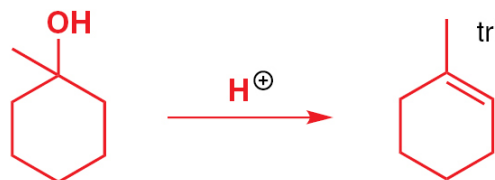
E1 | Estereoquímica

- Regioquímica e estereoquímica.

only one alkene possible

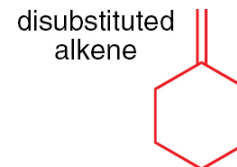


two **regioisomeric** alkenes possible



trisubstituted
alkene

and/or



disubstituted
alkene

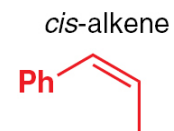
regioisomers

two **stereoisomeric** alkenes possible



trans-alkene

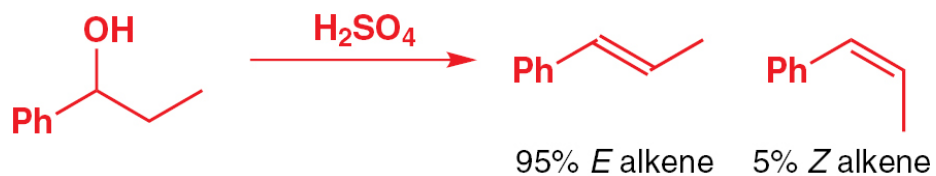
and/or



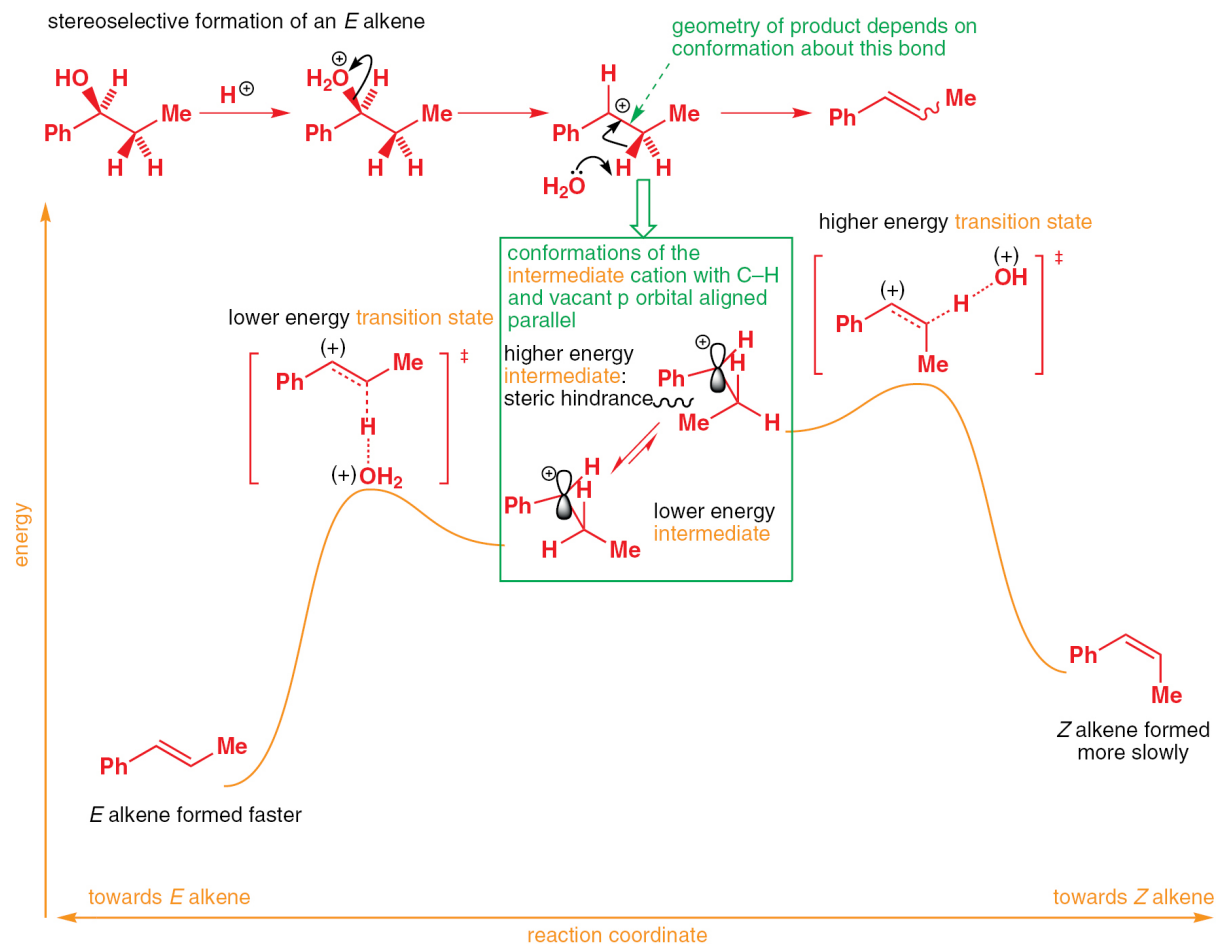
cis-alkene

stereoisomers
(geometrical isomers)

E1 | Estereoquímica



Exemplo de reação **estereosseletiva**
Um dos estereoisômeros se forma em maior quantidade



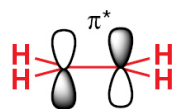
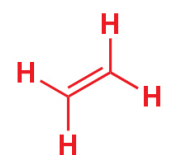
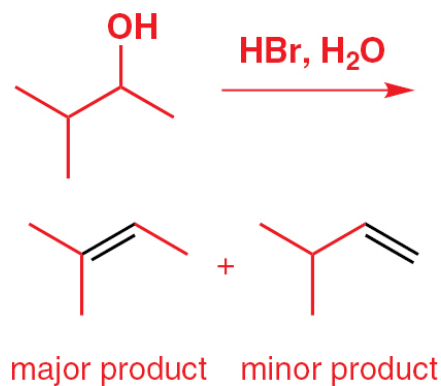


Eliminação-β

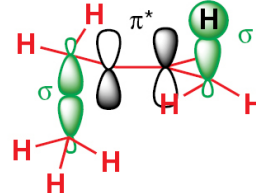
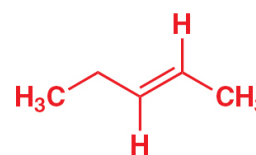
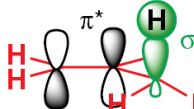
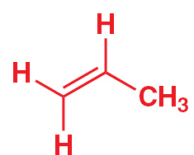
E1 | Estereoquímica

- Alcenos mais substituídos são mais estáveis, devido à hiperconjugação.

Exemplo de reação **regiosseletiva**



no C-H bonds
parallel with π^*

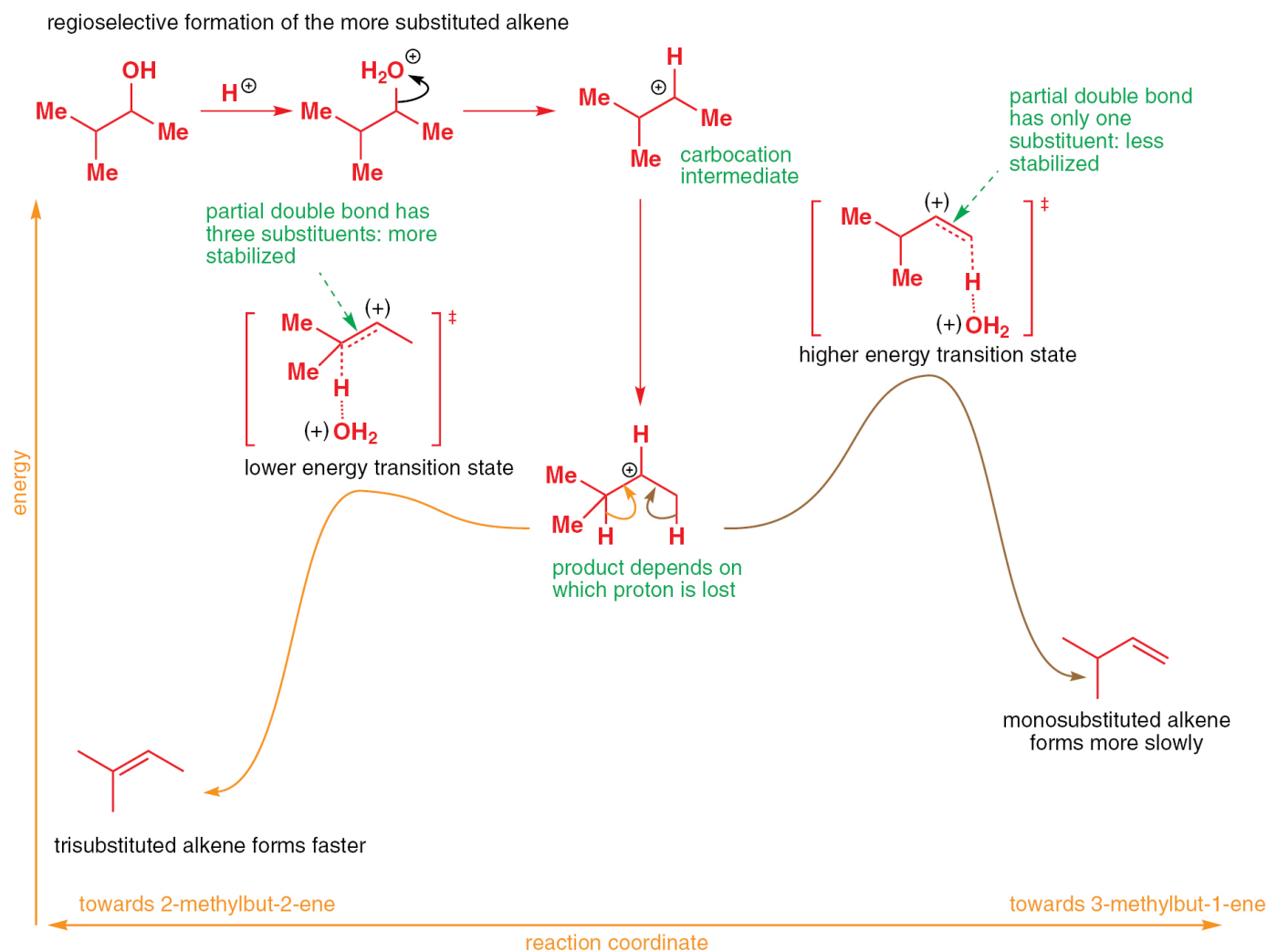


increasing substitution
allows more C-H
and C-C σ orbitals
to interact with π^*

E1 | Estereoquímica

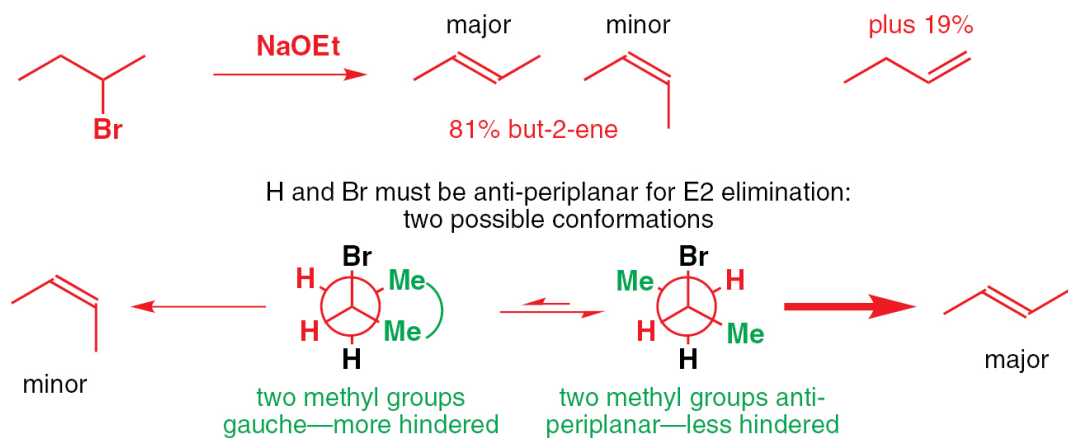
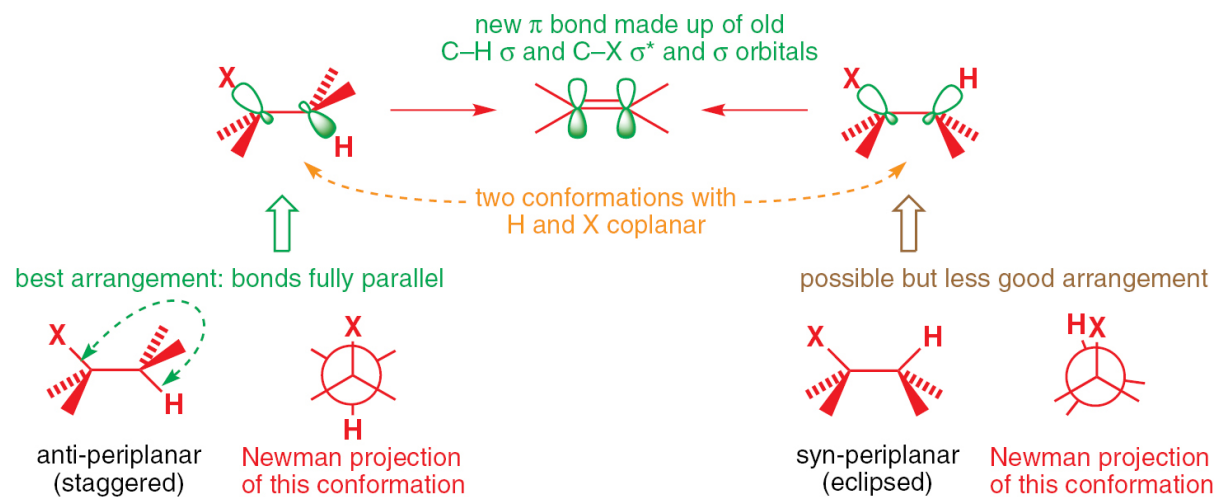
Exemplo de reação **regiosseletiva**

Um dos regioisômeros se forma em maior quantidade



E2 | Estereoquímica

- Estado de transição E2 é antiperiplanar.

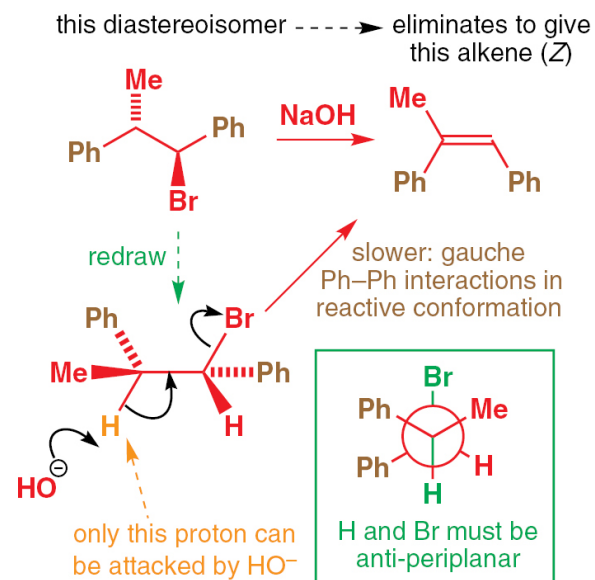
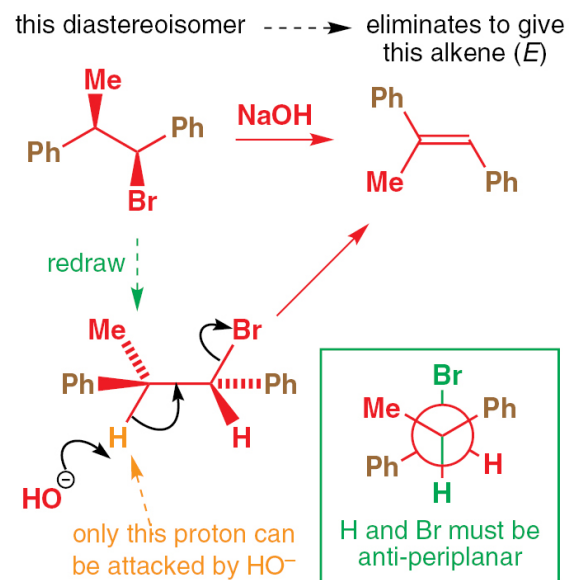




Eliminação-β

E2 | Estereoquímica

- E2 pode ser estereoespecífica: só se forma um único estereoisômero.

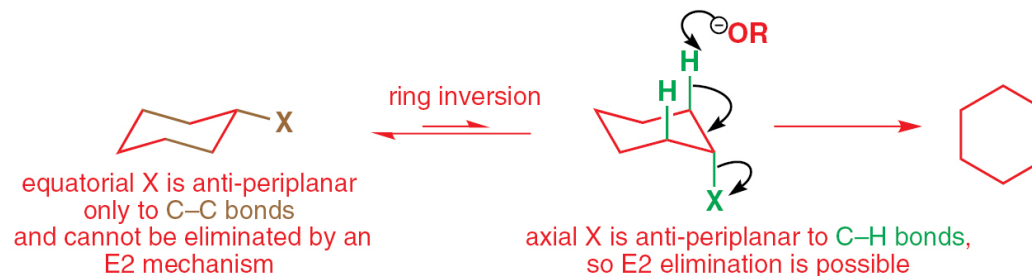




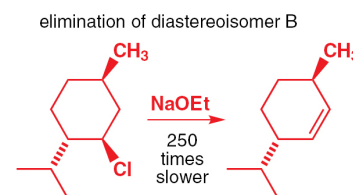
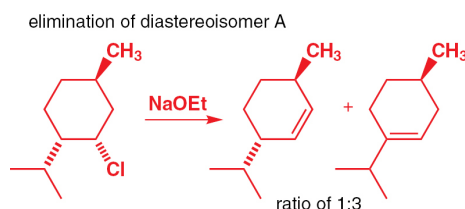
Eliminação-β

Eliminação em cicloexanos

- E2 pode ser estereoespecífica: só se forma um único estereoisômero.



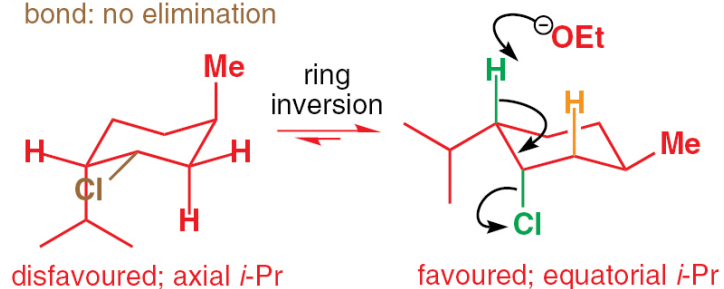
Mecanismo só pode ser E2
Qual seria o produto por E1?



conformation of diastereoisomer A

No C-H bonds anti-periplanar to the C-Cl bond: no elimination

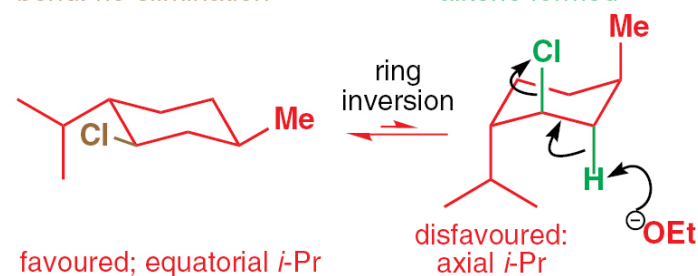
two anti-periplanar C-H bonds: either can eliminate to give different products



conformation of diastereoisomer B

No C-H bonds anti-periplanar to the C-Cl bond: no elimination

one anti-periplanar C-H bond: single alkene formed

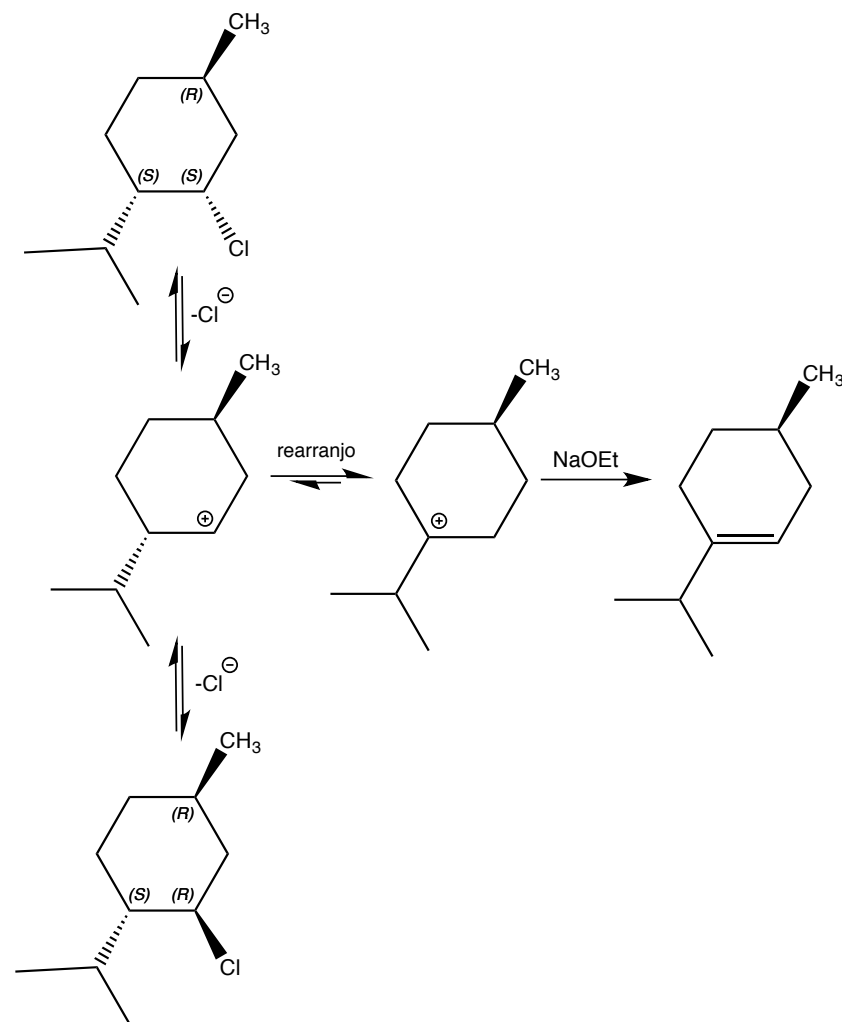




Eliminação-β

Eliminação em cicloexanos

- Produto de A e B via E1.

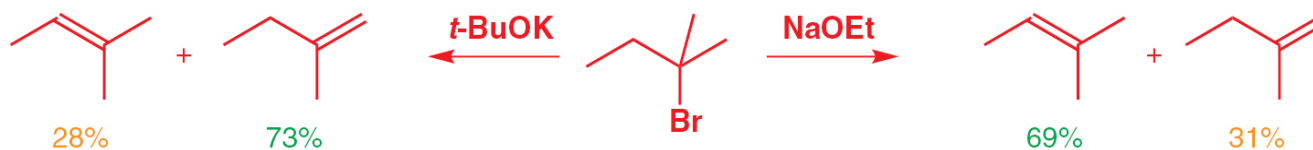
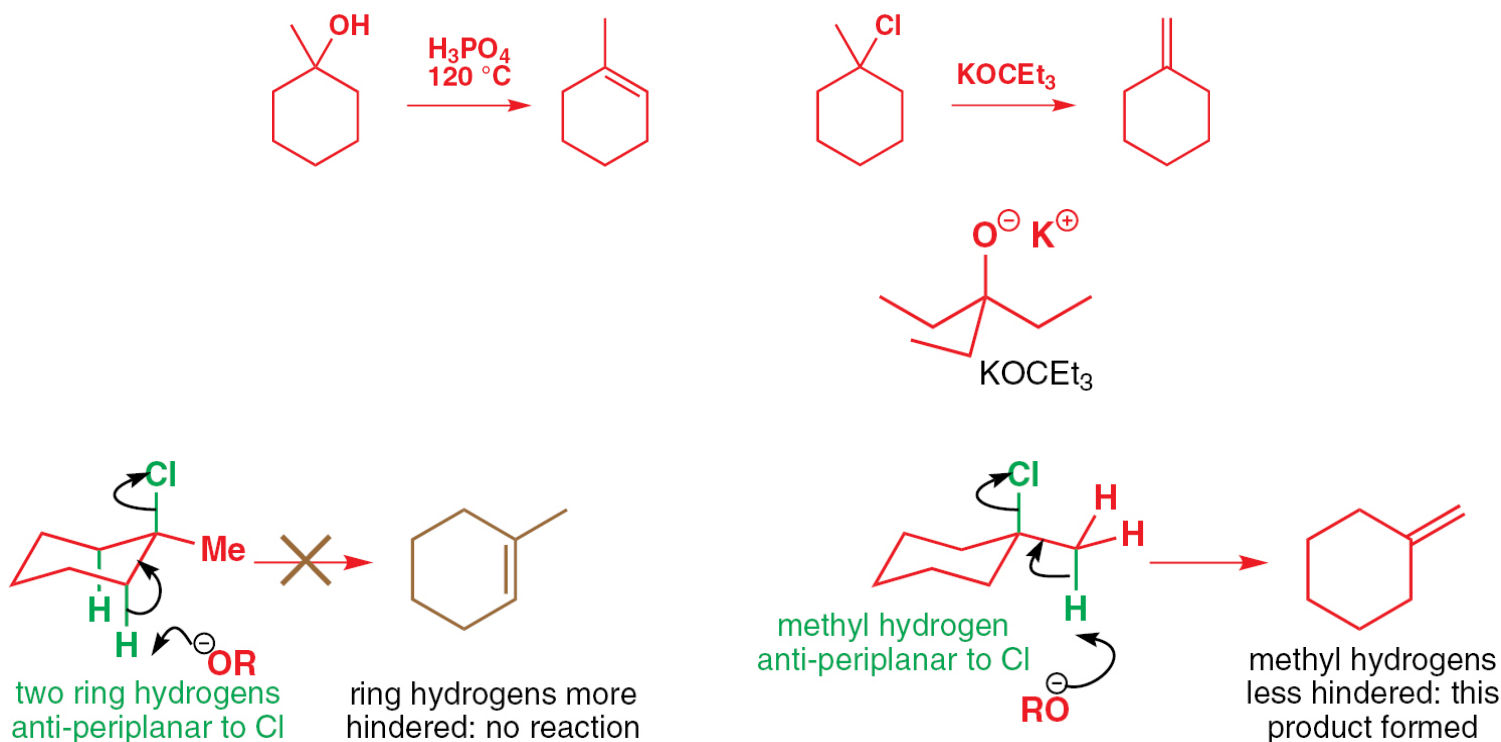




Eliminação-β

E2 | Estereoquímica

- Regiosseletividade. Uso de base forte e impedida pode levar ao alceno menos estável.

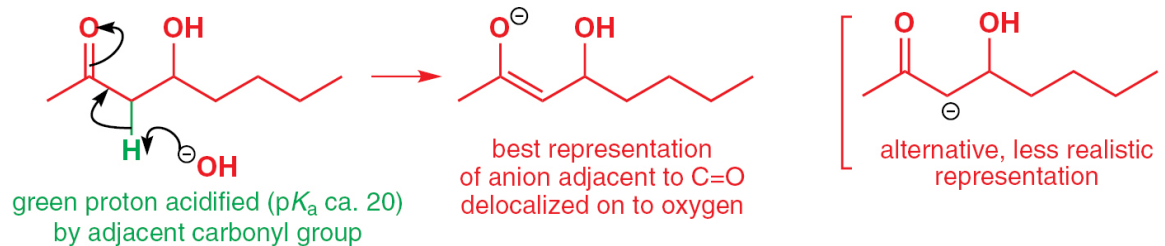




Eliminação-β

E1cb

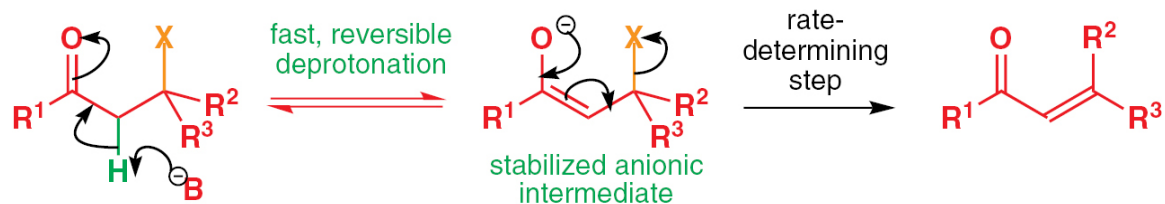
- Eliminação E1 via base conjugada, E1cb. Acontece quando o grupo abandonador é ruim.



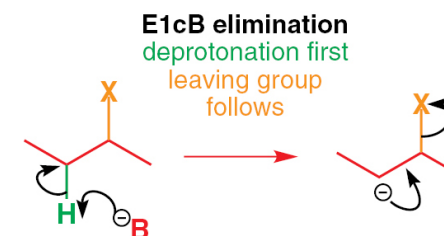
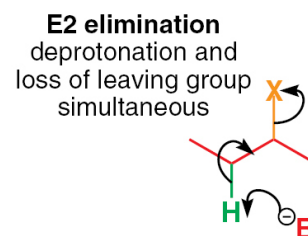
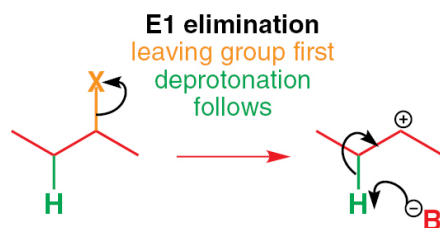
the elimination step by the E1cB mechanism



the E1cB mechanism



Resumo

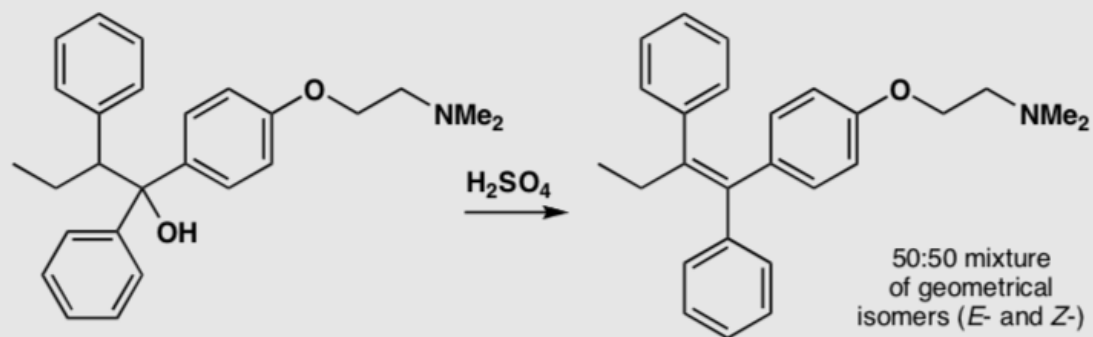


		Poor nucleophile (e.g. H ₂ O, ROH)	Weakly basic nucleophile (e.g. I ⁻ , RS ⁻)	Strongly basic, unhindered nucleophile (e.g. RO ⁻)	Strongly basic, hindered nucleophile (e.g. DBU, t-BuO ⁻)
methyl	<chem>H3C-X</chem>	no reaction	S _N 2	S _N 2	S _N 2
primary (unhindered)	<chem>CH3CH2CH2X</chem>	no reaction	S _N 2	S _N 2	E2
primary (hindered)	<chem>(CH3)2CHCH2X</chem>	no reaction	S _N 2	E2	E2
secondary	<chem>(CH3)2CHCHX</chem>	S _N 1, E1 (slow)	S _N 2	E2	E2
tertiary	<chem>(CH3)3CX</chem>	E1 or S _N 1	S _N 1, E1	E2	E2
β to anion-stabilizing group	<chem>CH3C(=O)CH2CHX</chem> α β	E1cB	E1cB	E1cB	E1cB

Problemas

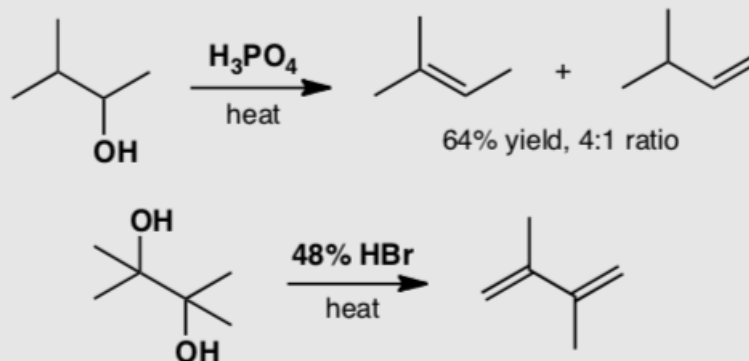
PROBLEM 2

Give a mechanism for the elimination reaction in the formation of tamoxifen, a breast cancer drug, and comment on the roughly 50:50 mixture of geometrical isomers (*cis*- and *trans*-alkenes)



PROBLEM 3

Suggest mechanisms for these eliminations. Why does the first give a mixture and the second a single product?



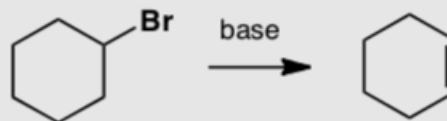


Eliminação-β

Problemas

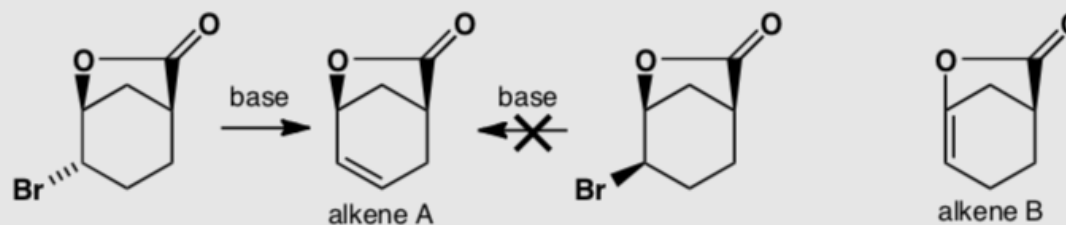
PROBLEM 8

Why is it difficult (though not impossible) for cyclohexyl bromide to undergo an E2 reaction? What conformational changes must occur during this reaction?



PROBLEM 9

Only one of these bromides eliminates to give alkene A. Why? Neither alkene eliminates to give alkene B. Why not?





Eliminação-β

Problemas

PROBLEM 10

Account for the contrasting results of these two reactions.

