(4) **Today**

Sections 11.1 - 11.6: Substitution Reactions

Sections 10.5, 17.6: Alcohols in Nucleophilic Substitution Reactions

Next Class (5)

Sections 10.5, 17.6: Alcohols in Nucleophilic Substitution Reactions

Sections 11:7 - 11:11: Elimination Reactions

(6) **Second Class from Today**

Sections 11:7 - 11:11: Elimination Reactions

Third Class from Today (7)

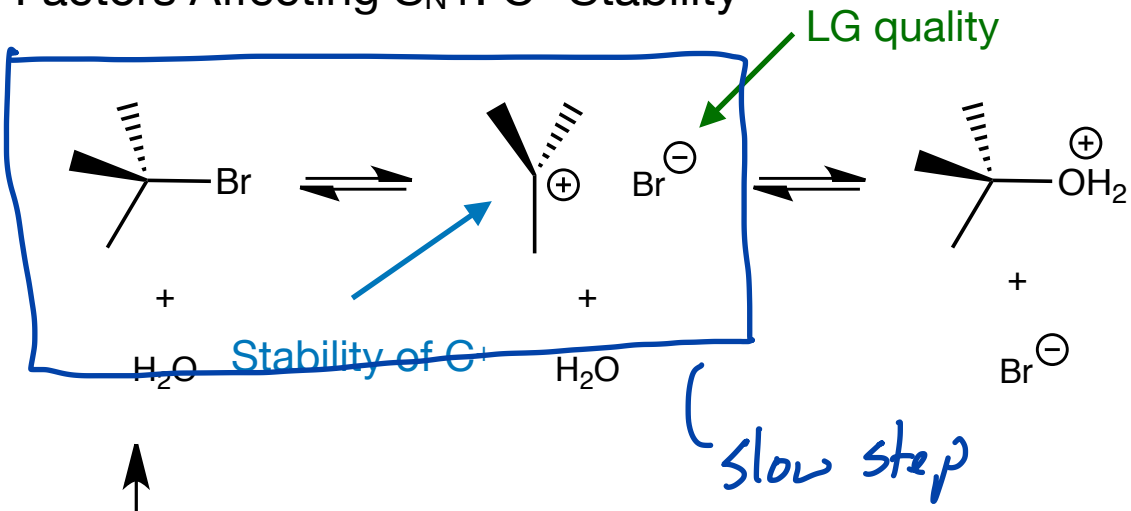
Sections 11:7 - 11:11: Elimination Reactions

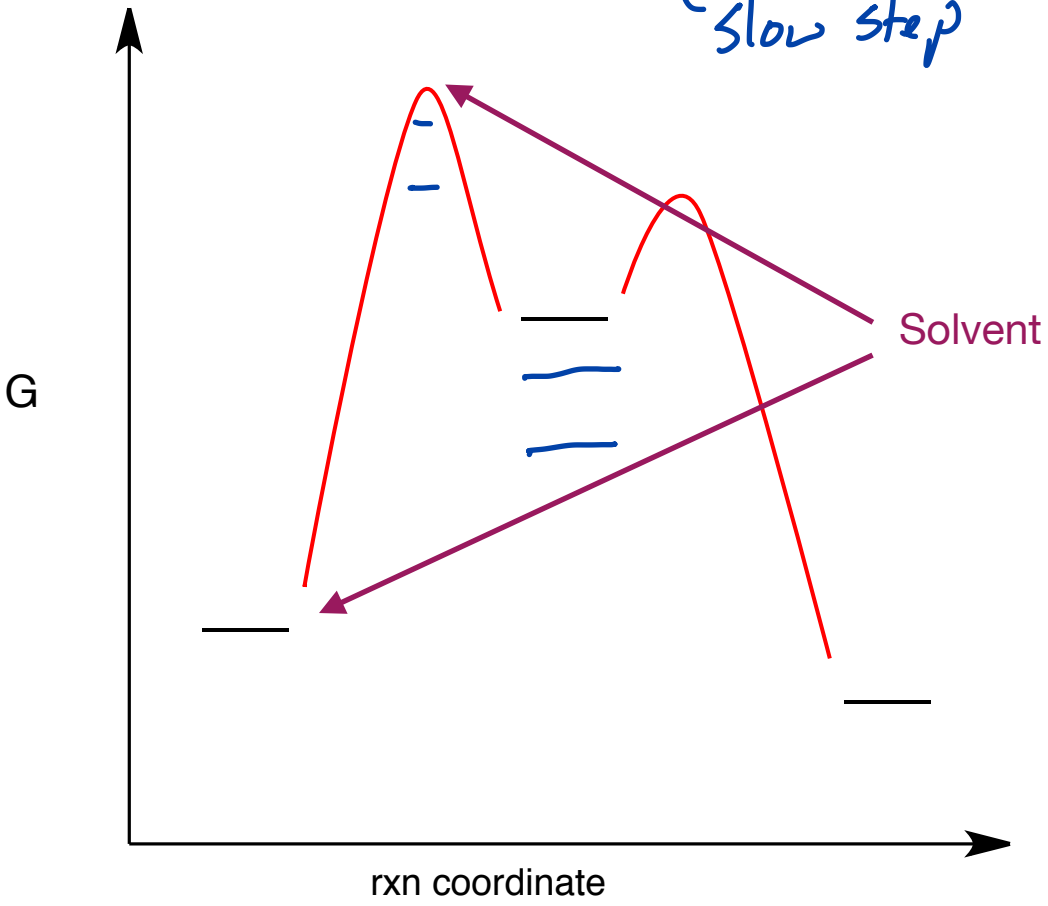
Section 17.6: Alcohols and Elimination Reactions

Competition between S_N1, E1, S_N2, and E2

Chap 12: Mass Spectrometry and Infrared Spectroscopy

Factors Affecting S_N1: C^+ Stability





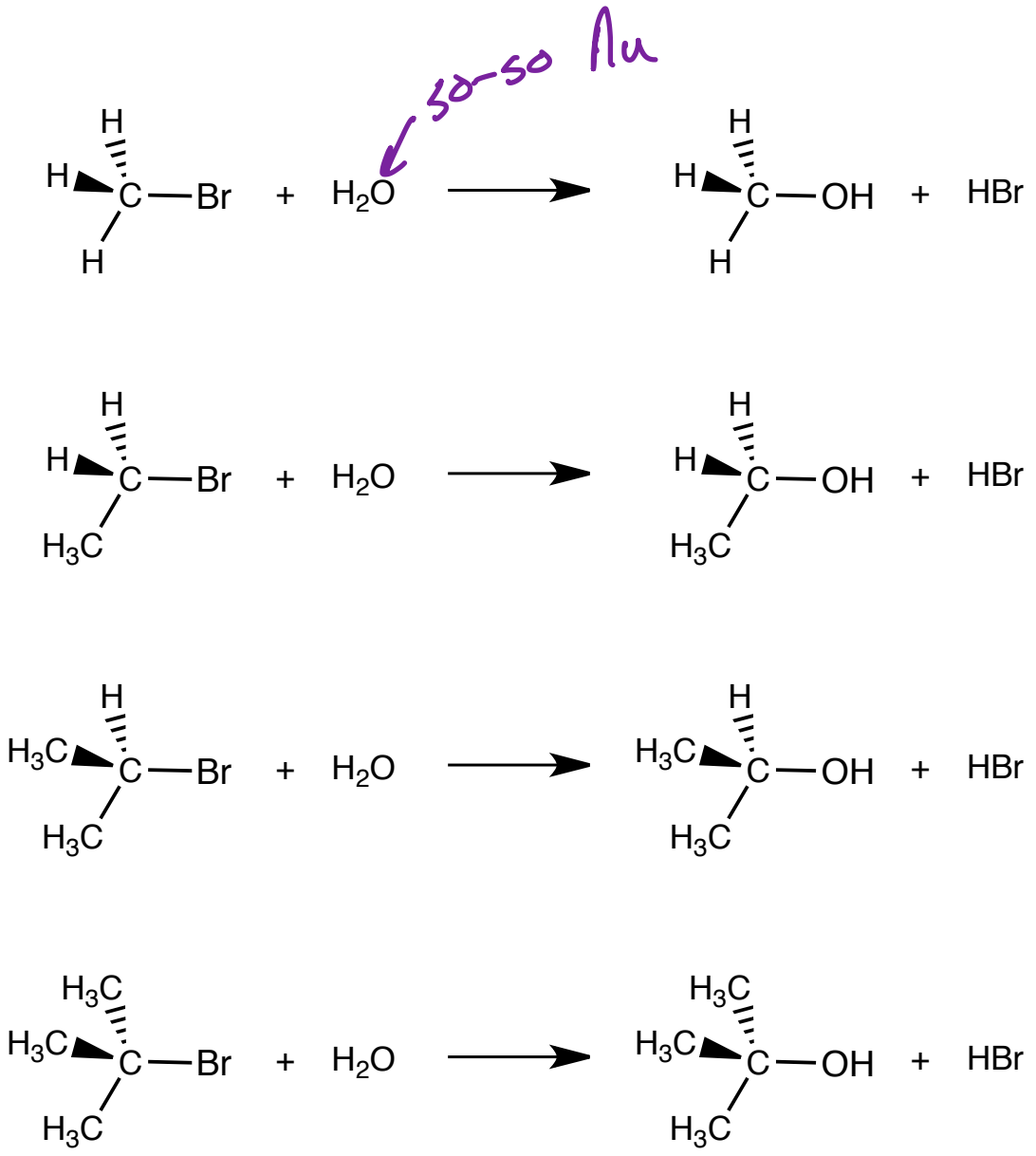
The more stable the C^+ the faster the rxn

LG has to leave.

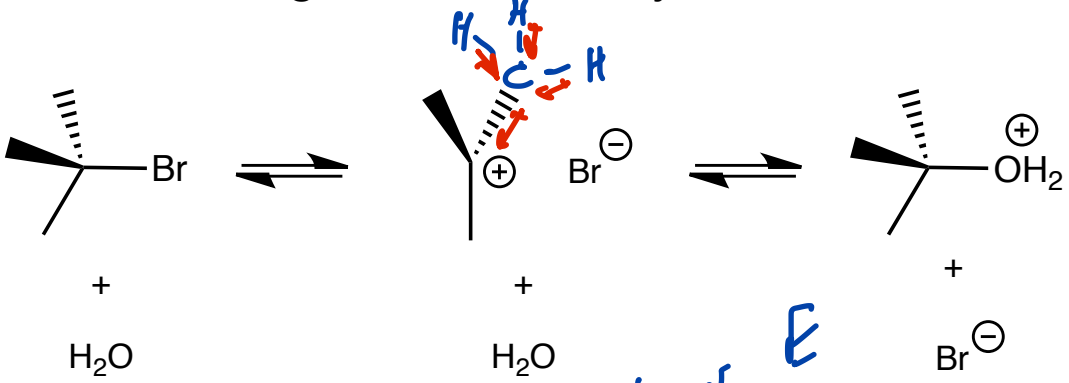
The better the LG the faster the S_N1 rxn

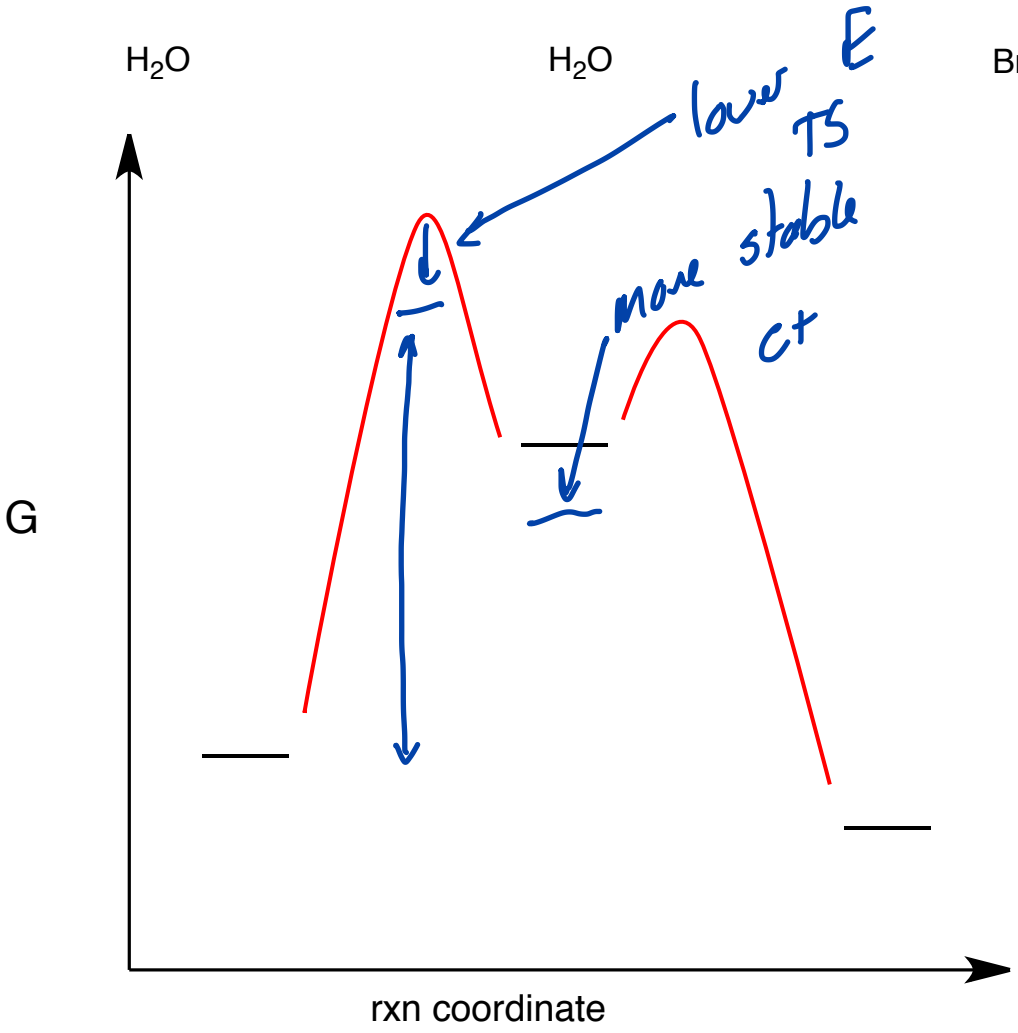
Solvent stabilize TS or destabilize reactant

Rates of Hydrolysis of Alkyl Bromides



[1]Organic Chemistry, a 10th edition. McMurray, OpenStax





as C^+ becomes more stable.. the TS that leads to the C^+ goes down in E

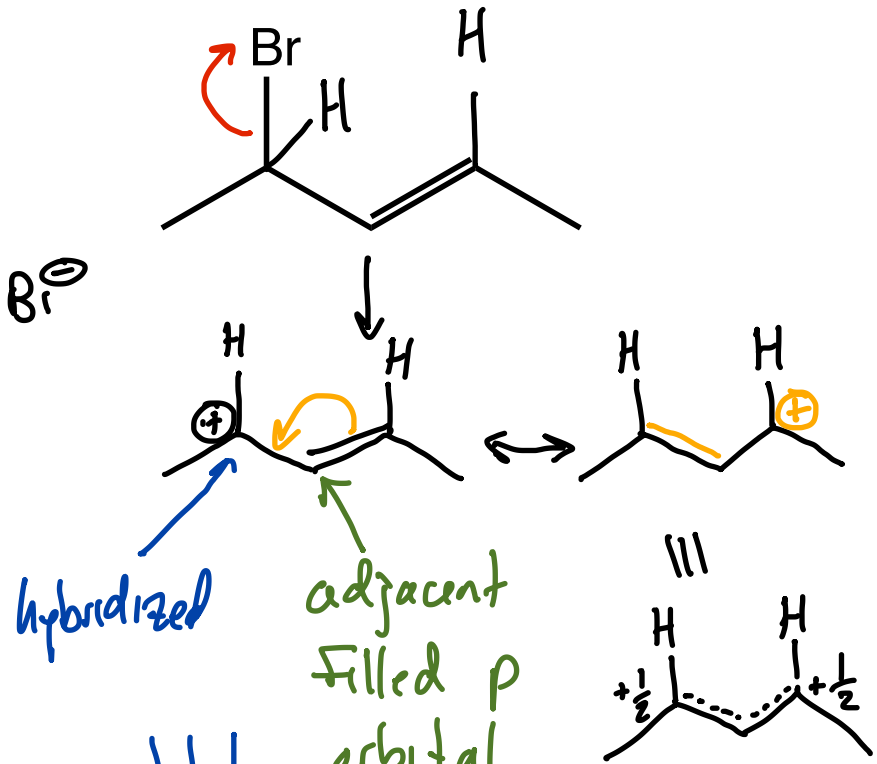
so the rate increases

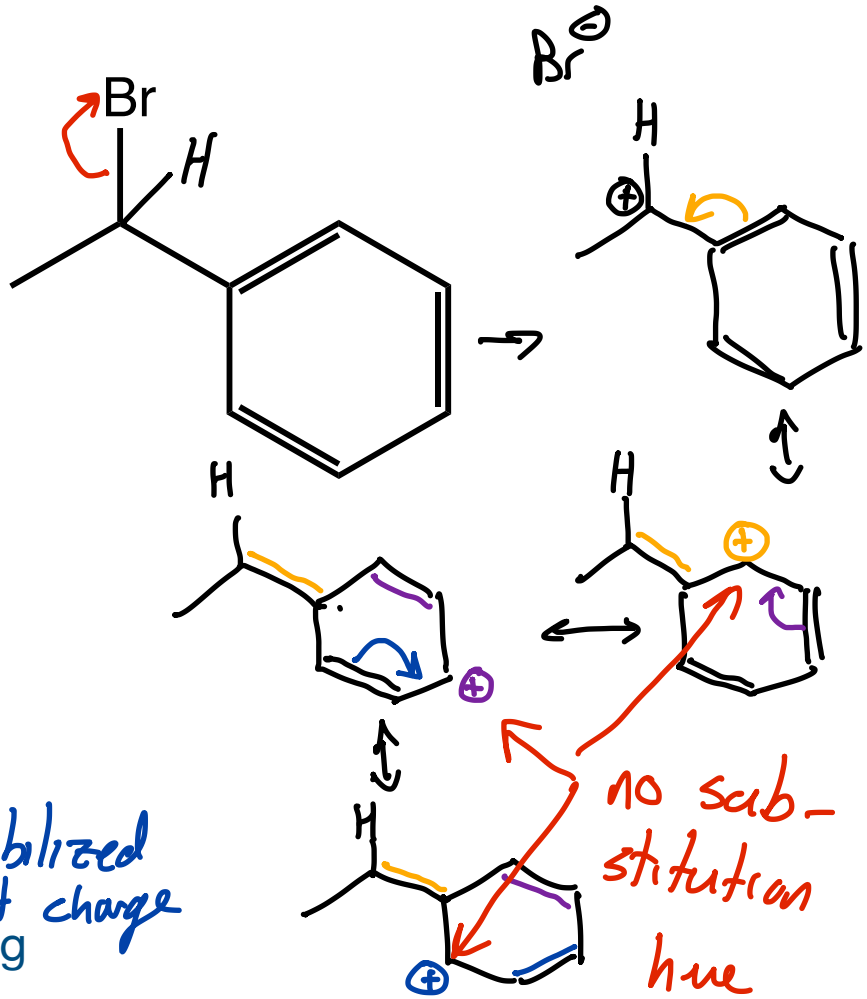
[3° C^+ / 3° α-C fast S_N1
2° C^+ with resonance
2° C^+ / 2° α-C slow S_N1
1° C^+ with resonance S_N2 predominates

~~1° C^+~~ / 1° α-C

~~Methyl~~ C^+ / methyl α-C

Allylic and Benzylic Positions



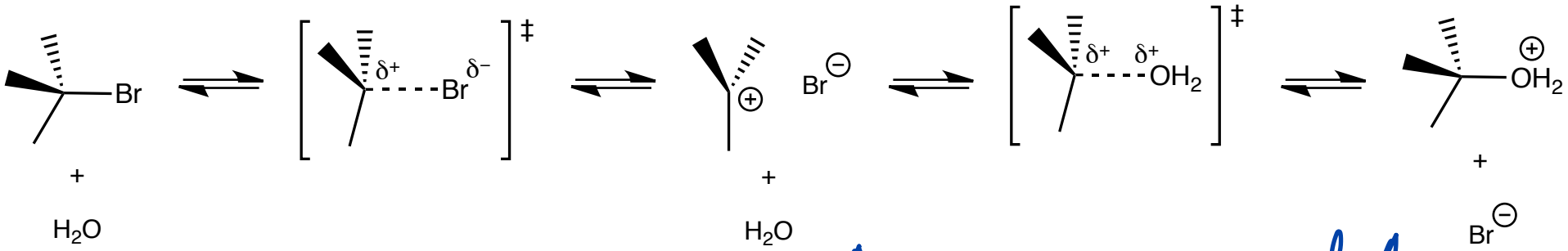


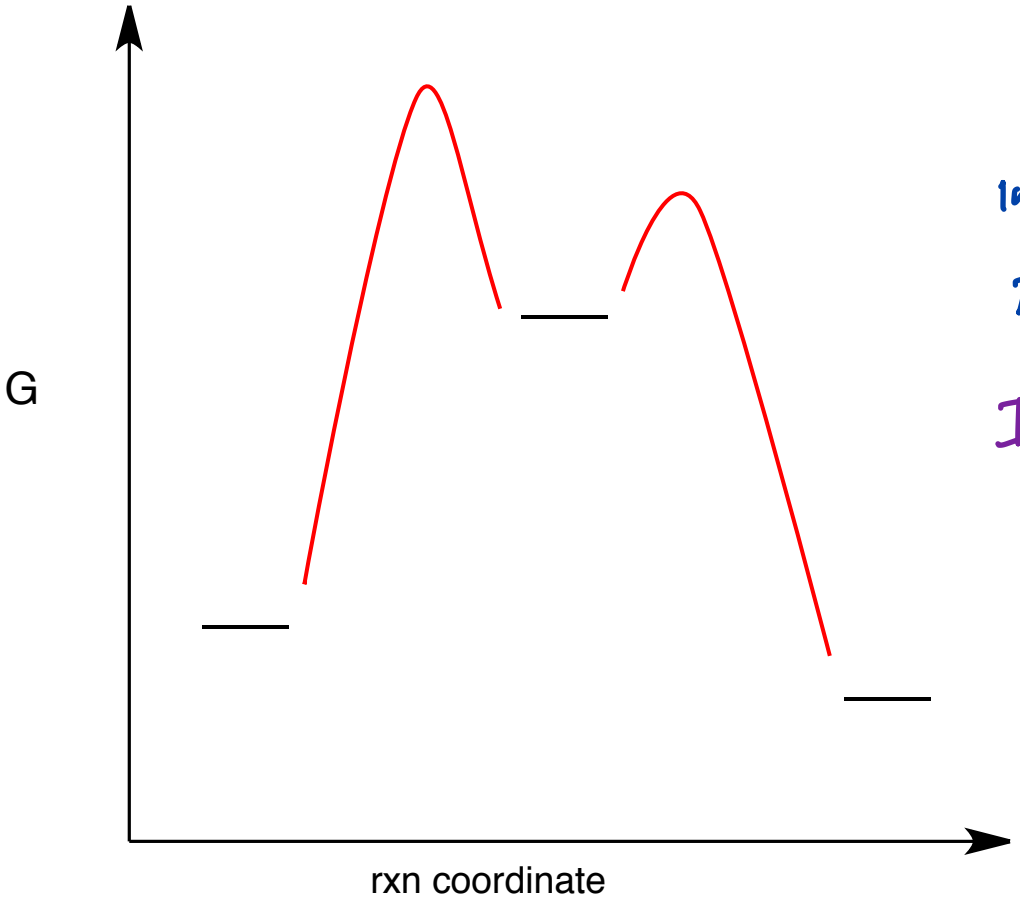
Stability Ranking

3° C⁺ > 2° C⁺ > 1° C⁺ > methyl C⁺

3° C⁺ with resonance > 2° C⁺ with resonance > 1° C⁺ with resonance

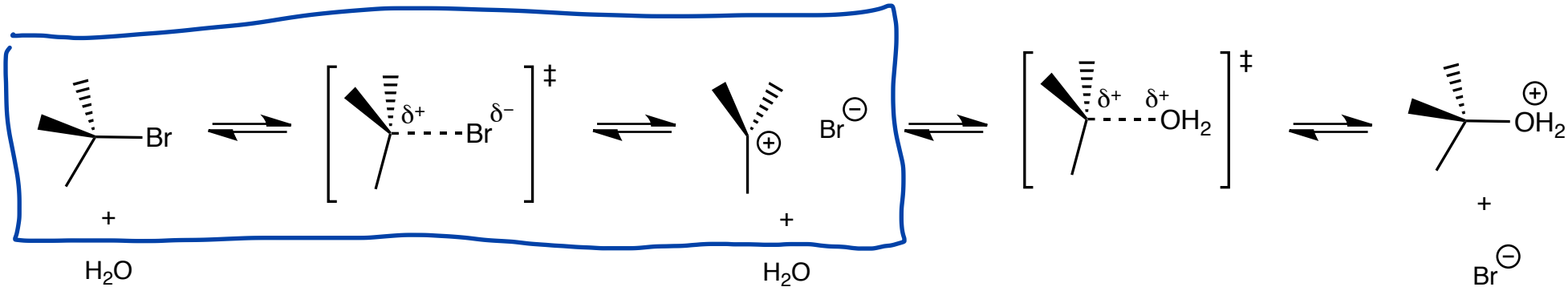
S_N1 | S_N1 S_N2 | mostly S_N2

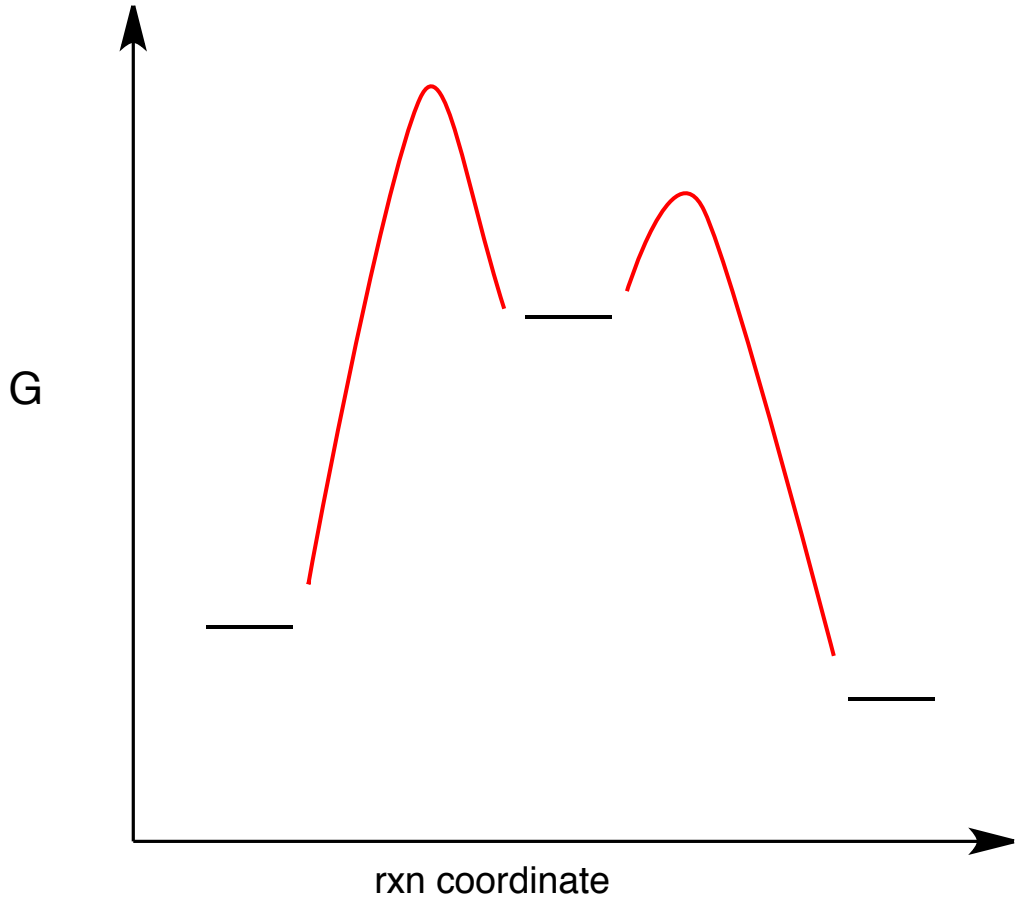




No role ... a good Nu won't speed up the rxn in S_N1 because in S_N1 the C+ must form first.

If too strong a Nu is used elimination will result with 3° α-C





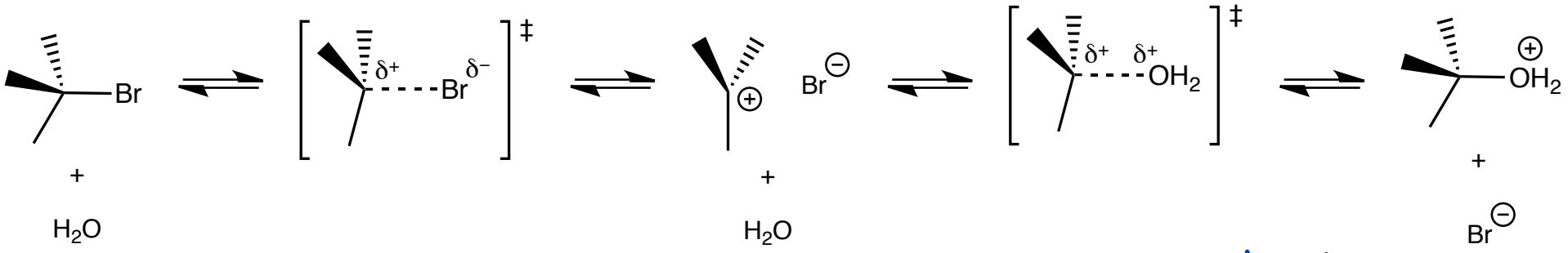
No role for the Nu in the rate determing step

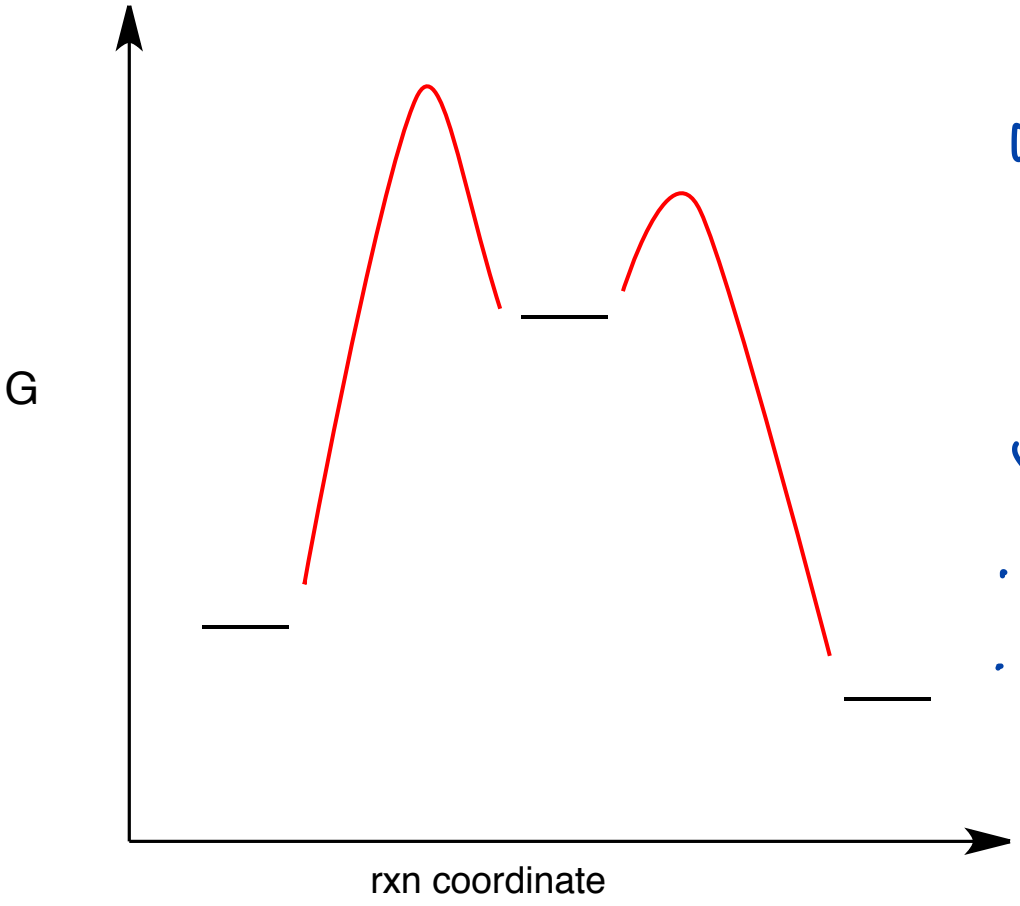
H-Ö-H weak nucleophile

H-Ö:⊖ strong nucleophile
strong base

3° α-C ... cannot access backside of α-C ... no S_N2.

H-O⊖ too reactive to wait for C+ formation elimination





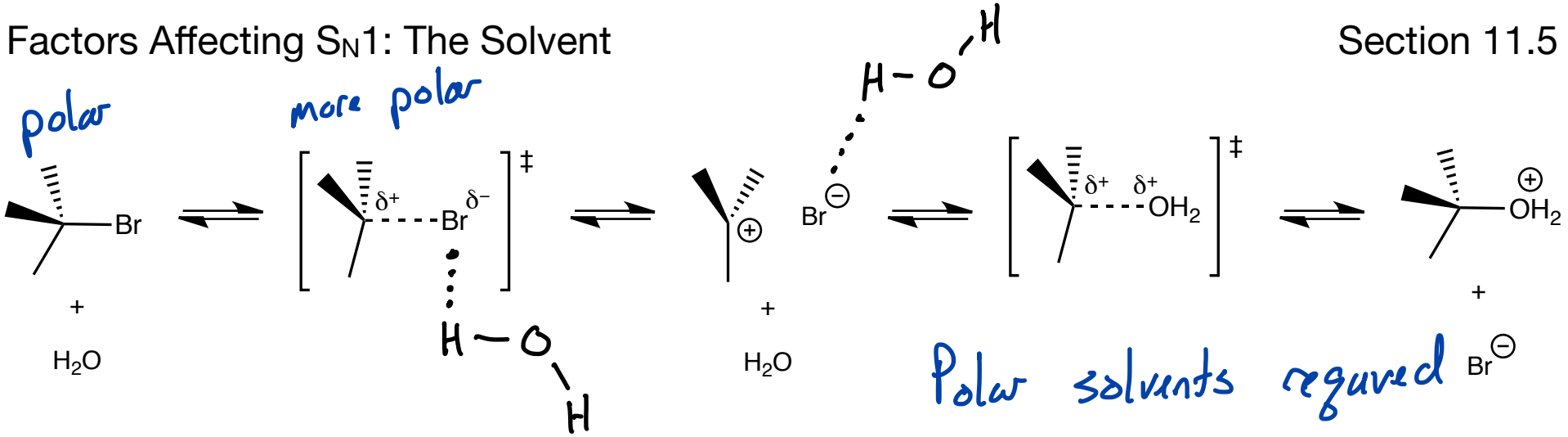
Leaving group must leave...

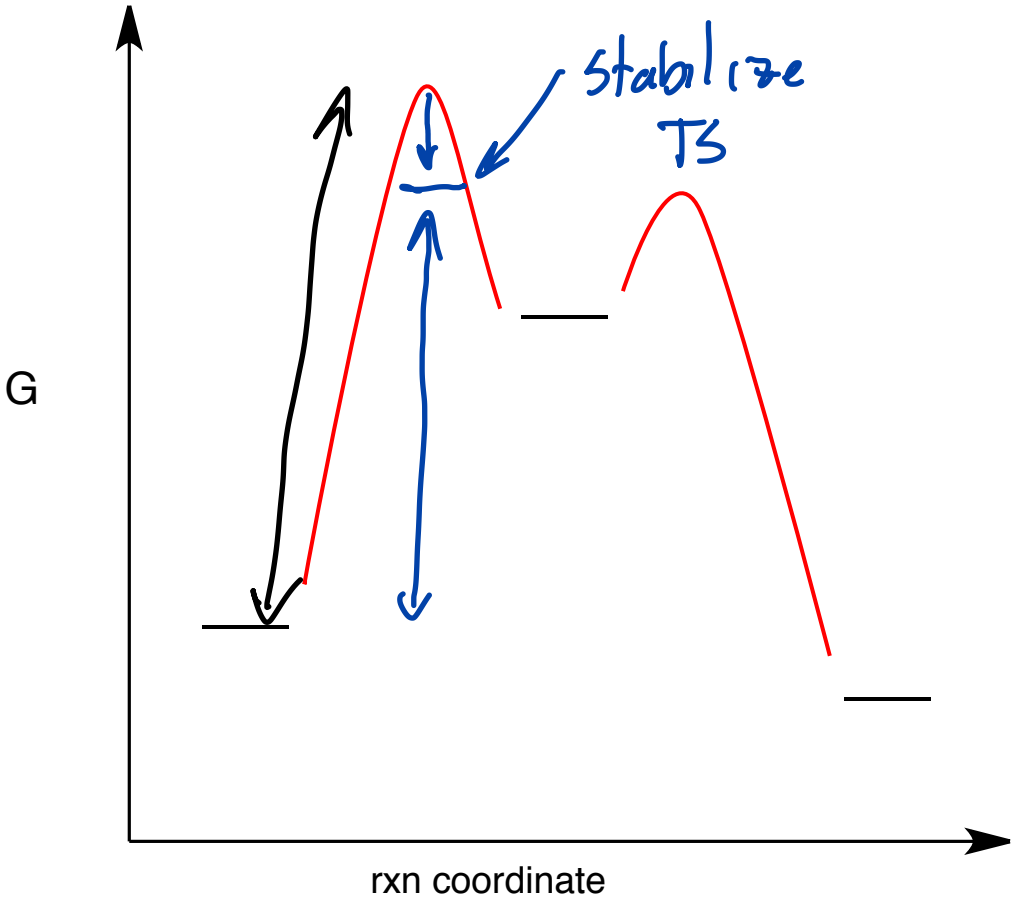
weak bond and a stable ion/molecule makes for a good LG.

- extremely weakly basic
- conjugate base of a strong acid

polar

more polar





Polar solvents required

protic vs aprotic

(OH) (NH)

H-bond donor solvents

not H-bond donors

protic solvents stabilize the ⊖ forming on the LG by forming H-bond like interaction with LG and stabilize the LG once it has left

High degree of substitution on α-C or electron delocalization to promote C^+ stability

1° α-C < 2° α-C ~ 1° allylic ~ 1° benzylic < 3° α-C ~ 2° allylic ~ 2° benzylic < 3° allylic ~ 3° benzylic

S_N1 possible

S_N2 predominates

no S_N2

S_N1 possible

S_N2 possible

no S_N2

Protic Solvents - encourage S_N1 mechanisms

Help stabilize transition state by stabilizing (–) charge that builds on LG as α-C to LG bond breaks

Good Leaving Group

LG's that are low in energy (very weakly basic atoms/molecules) make forming the C^+ intermediate easier

Weak Nucleophiles

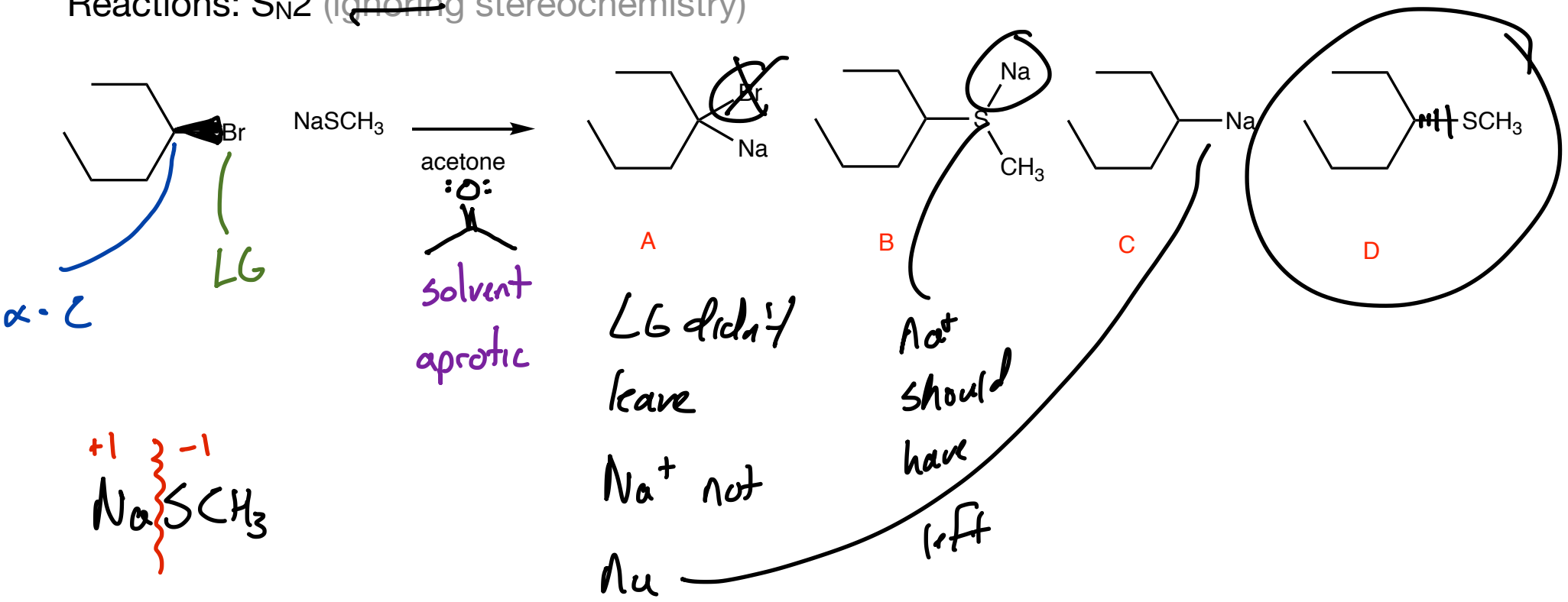
Weak Nu's have to wait for C^+ to form to react…

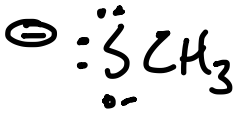
Strongly basic Nu's cause side reactions on 2° and 3° α-C's

S_N2	S_N1
Two molecules collide in a 1 step mechanism	Dissociation of **one molecule** controls the rate of a two step reaction
bimolecular rate determining step	**unimolecular** rate determining step
stereochemistry is inverted	stereochemistry is a mixture of inverted and retained (not inverted)
methyl, 1°, 2° good access to back of α-C	3° alkyl 2° allylic/benzylic substrates 2° with resonance
better the nucleophile the faster the reaction	the nucleophile is not involved in the rate determining step
good nucleophile	so so nucleophile
polar aprotic solvent	polar protic solvent (H-bond donor solvent)

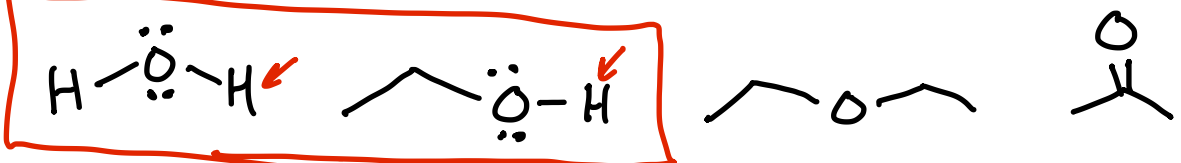
1. Find α-C + LG 2. Find Nu 3. Find + identify solvent

Reactions: S_N2 (ignoring stereochemistry)

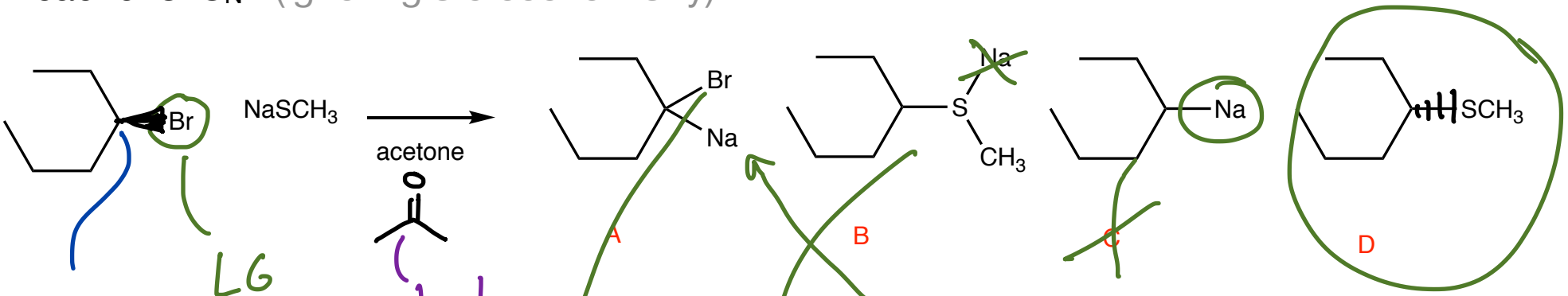




nucleophiles



Reactions: S_N2 (ignoring stereochemistry)



α-C

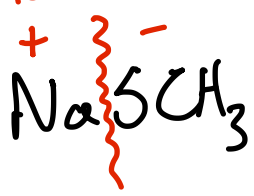
when substitution occurs

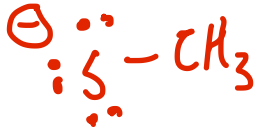
LG has to leave

Na^+ will be released

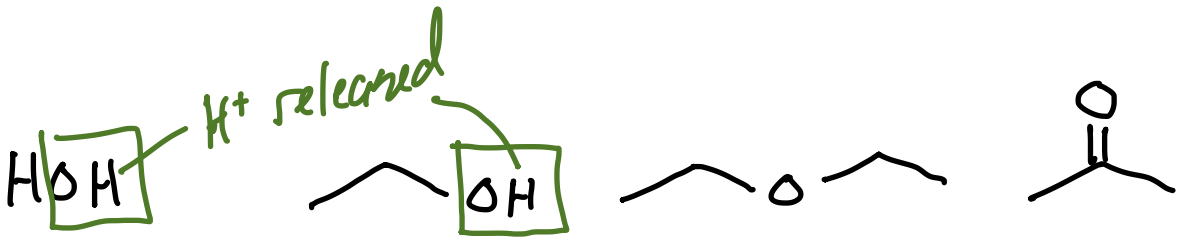
Na^+ is not nucleophilic

ionic

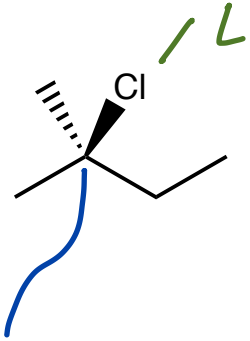




Nucleophile

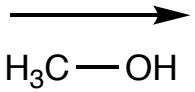


Reactions: S_N1 (not ignoring stereochemistry)

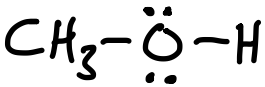


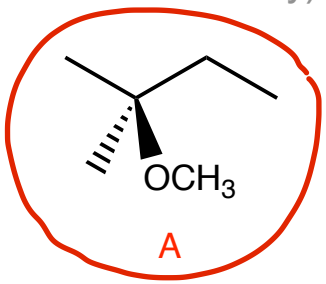
LG

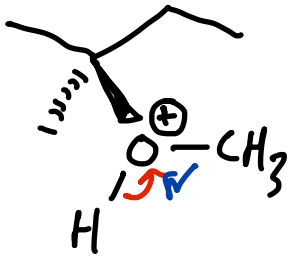
α-L

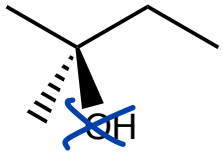


solvent and nucleophile

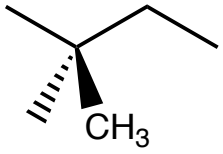




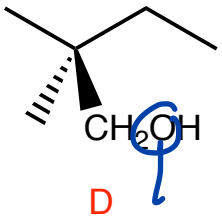




for this to form $^+CH_3$

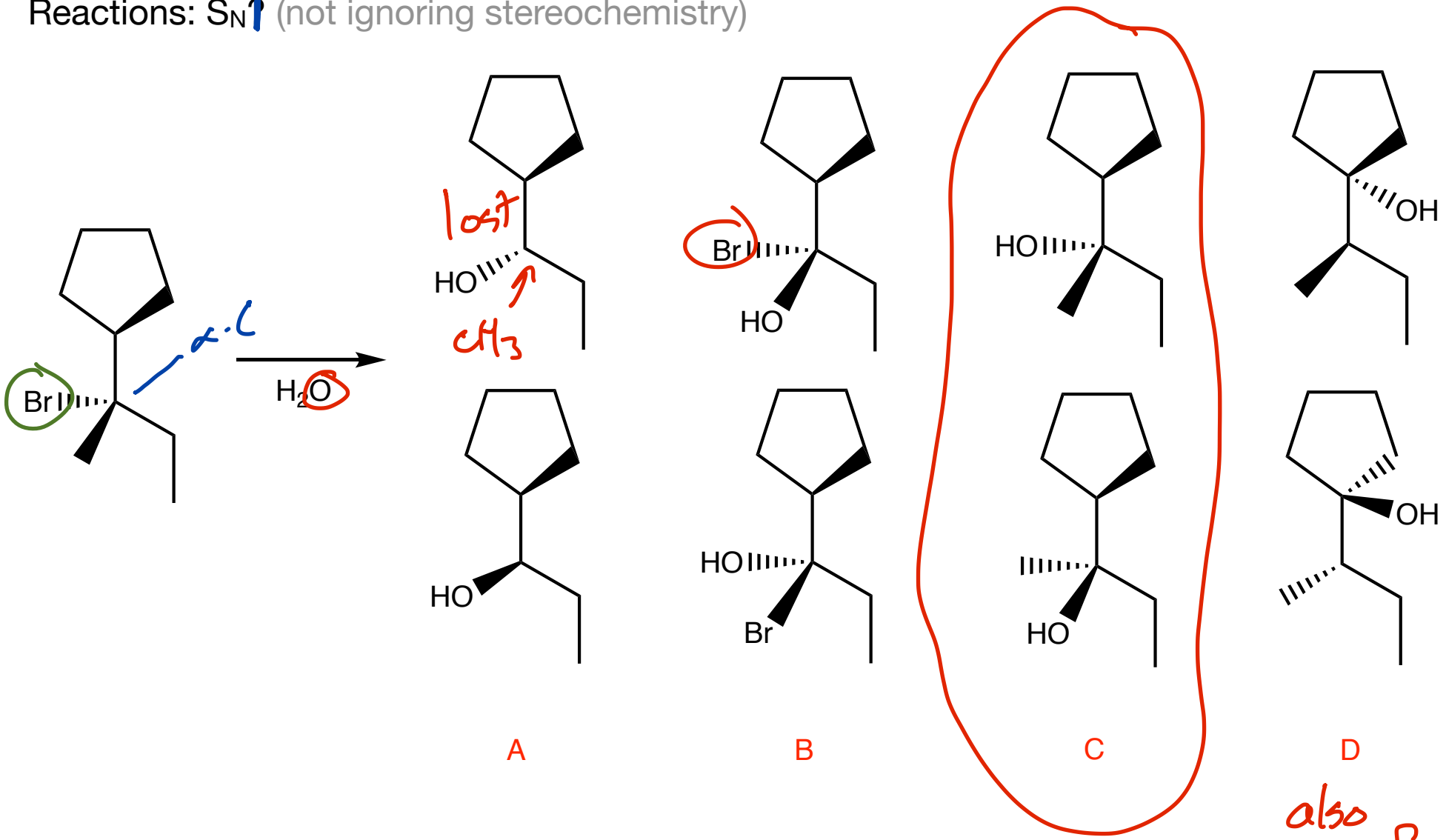


the O was the e⁻ rich part



nucleophilic atom

Reactions: S_N1 (not ignoring stereochemistry)

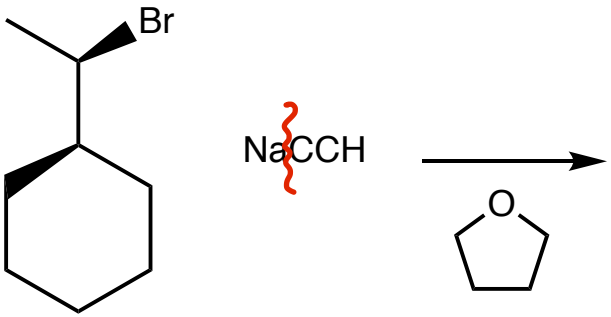


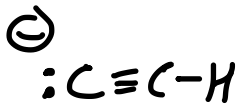
S_N? α-C? 3° α-C S_N1 ~~S_N2~~

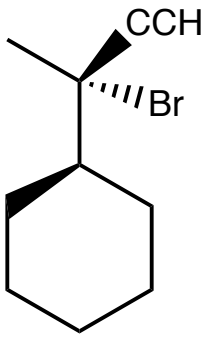
solvent? protic solvent encourages S_N1

also some of this because a small amt of C^+ rearrangement

Reactions: S_N2 (not ignoring stereochemistry)







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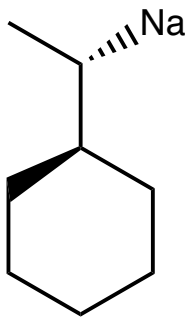

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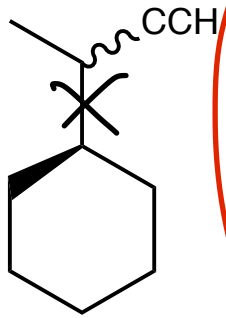

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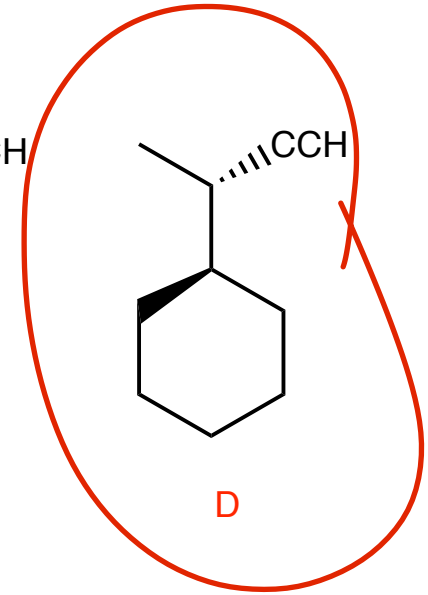

D

S_N2 inverts stereochem