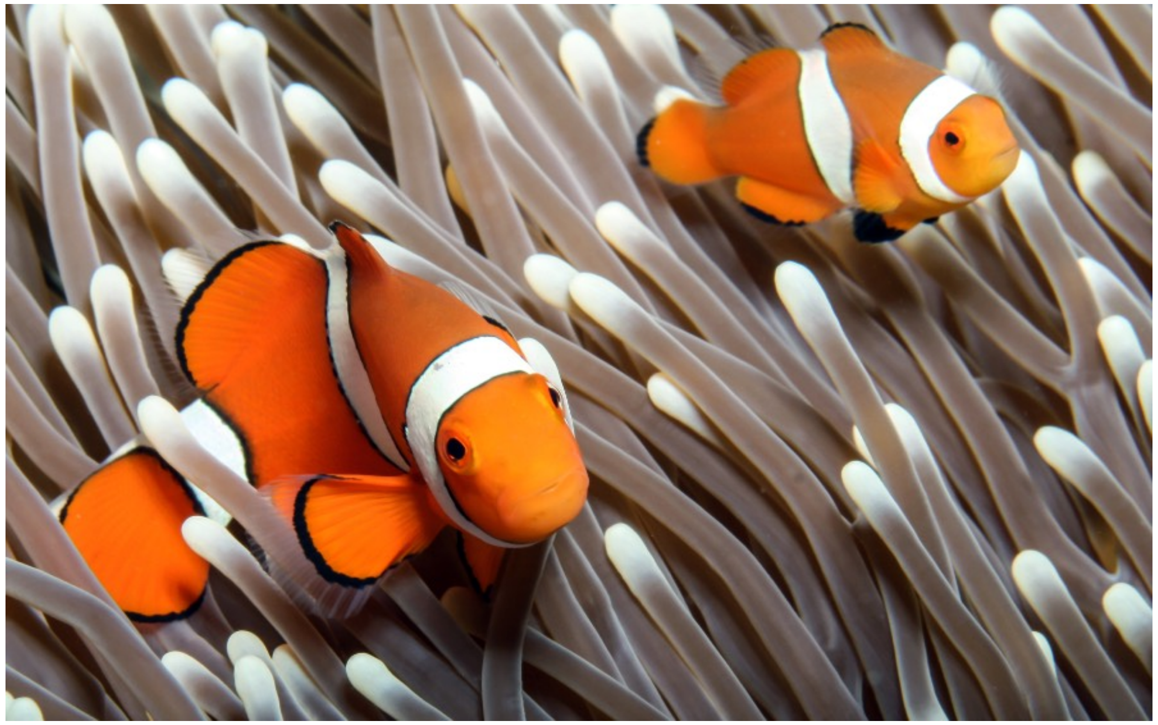
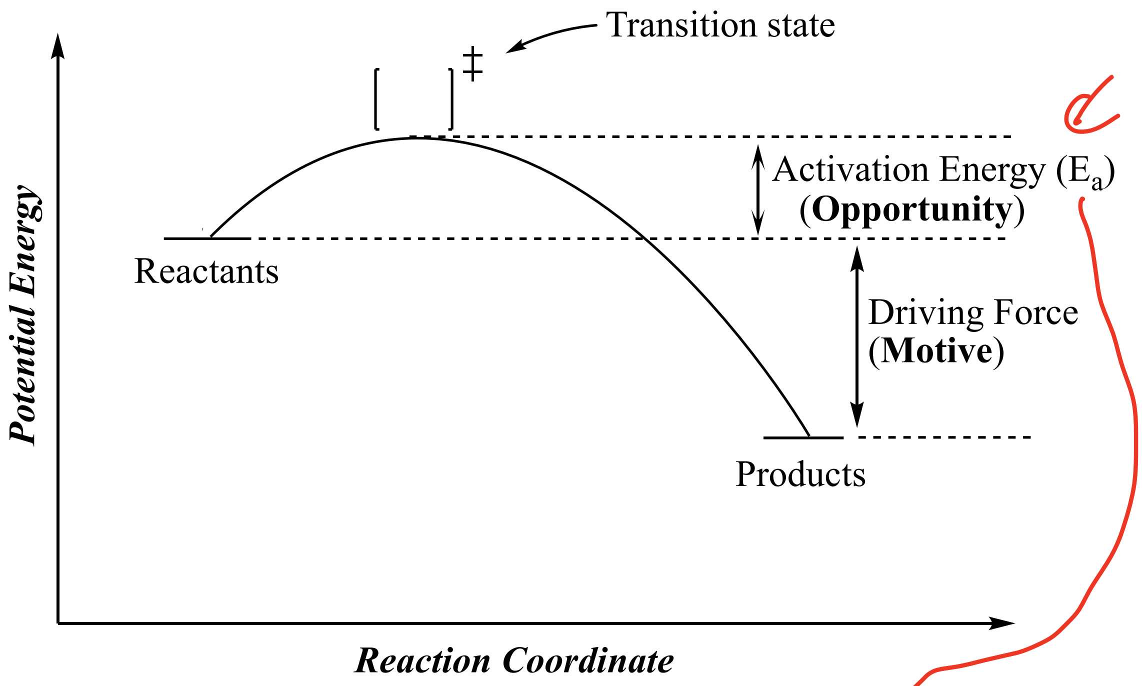
Tutors Reimagined

Organic Chemistry is a hard subject. For that reason, we are giving you two additional resources to help you **succeed beyond your wildest dreams**. I am not exaggerating, these are both effective!

First: Arushi Arora, an Actual Human Tutor This course is supported by Supplemental Instruction (SI) sessions run by a former very successful student in my class, Arushi Arora, working with the Sanger Learning Center. SI Sessions are led by experienced and trained students who develop engaging, structured, small-group activities for you to work through. These sessions are at
Monday 8:00 pm-9:00pm @ JES A305A
Thursday 3:30-4:30 pm @ JES A215A

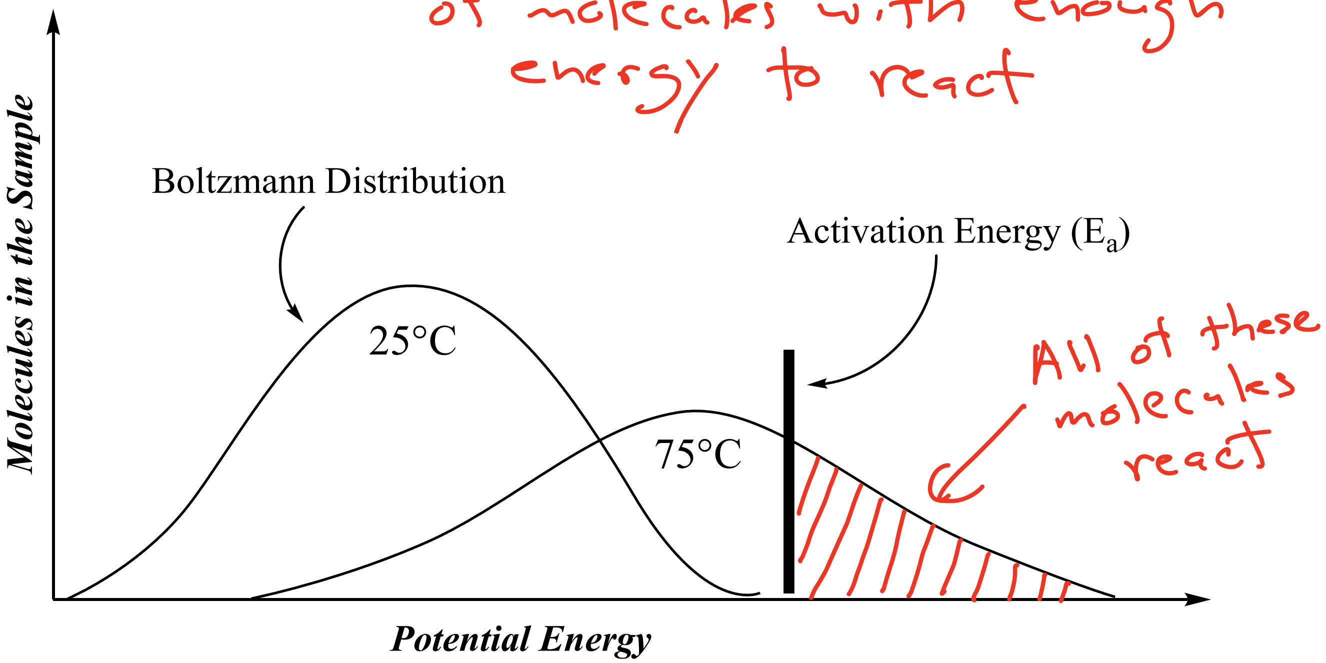


Second: AI Tutor
UT Sage is an AI tutor platform developed here at UT! We've created a tutorbot specifically for this course that can answer syllabus questions, clarify complex topics, and reinforce learning. **It's trained on the course textbook and resources** and allows you to ask questions in plain language and receive clear explanations informed by the course materials. Please use it as flexible resource for reviewing material or getting unstuck outside of class while being aware that generative AI tools can make mistakes. You can access your UT Sage tutor anytime in the Canvas navigation menu or by clicking here.

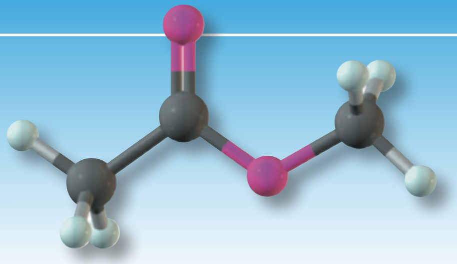


$$k = \text{reaction rate} = Ae^{-E_a/RT}$$

Increasing Temperature → increases the number of molecules with enough energy to react



Appendix 3



Bond Dissociation Enthalpies

Bond dissociation enthalpy (BDE) is defined as the amount of energy required to break a bond homolytically into two radicals in the gas phase at 25°C.

$$A{-}B \rightarrow A\cdot + B\cdot \qquad \Delta H^0 \text{ [kJ (kcal)/mol]}$$

Bond	ΔH^0
$H{-}H$ bonds	
$H{-}H$	435 (104)
$D{-}D$	444 (106)
$X{-}X$ bonds	
$F{-}F$	159 (38)
$Cl{-}Cl$	247 (59)
$Br{-}Br$	192 (46)
$I{-}I$	151 (36)
$H{-}X$ bonds	
$H{-}F$	568 (136)
$H{-}Cl$	431 (103)
$H{-}Br$	368 (88)
$H{-}I$	297 (71)
$O{-}H$ bonds	
$HO{-}H$	497 (119)
$CH_3O{-}H$	439 (105)
$C_6H_5O{-}H$	376 (90)
$O{-}O$ bonds	
$HO{-}OH$	213 (51)
$CH_3O{-}OCH_3$	159 (38)
$(CH_3)_3CO{-}OC(CH_3)_3$	159 (38)
$C{-}C$ single bonds	
$CH_3{-}CH_3$	378 (90)
$C_2H_5{-}CH_3$	372 (89)
$CH_2{=}CH{-}CH_3$	422 (101)
$CH_2{=}CHCH_2{-}CH_3$	322 (77)
$C_6H_5{-}CH_3$	435 (104)
$C_6H_5CH_2{-}CH_3$	326 (78)
$C{-}C$ multiple bonds	
$CH_2{=}CH_2$	727 (174)
$HC{\equiv}CH$	966 (231)
$C{-}H$ bonds	
$CH_3{-}H$	439 (105)
$C_2H_5{-}H$	422 (101)
$(CH_3)_2CH{-}H$	414 (99)
$(CH_3)_3C{-}H$	405 (97)
$CH_2{=}CH{-}H$	464 (111)
$CH_2{=}CHCH_2{-}H$	372 (89)
$C_6H_5{-}H$	472 (113)
$C_6H_5CH_2{-}H$	376 (90)
$HC{\equiv}C{-}H$	556 (133)
$C{-}F$ bonds	
$CH_3{-}F$	481 (115)
$C_2H_5{-}F$	472 (113)
$(CH_3)_2CH{-}F$	464 (111)
$C_6H_5{-}F$	531 (127)
$C{-}Cl$ bonds	
$CH_3{-}Cl$	351 (84)
$C_2H_5{-}Cl$	355 (85)
$(CH_3)_2CH{-}Cl$	355 (85)
$(CH_3)_3C{-}Cl$	355 (85)
$CH_2{=}CHCH_2{-}Cl$	288 (69)
$C_6H_5{-}Cl$	405 (97)
$C_6H_5CH_2{-}Cl$	309 (74)
$C{-}Br$ bonds	
$CH_3{-}Br$	301 (72)
$C_2H_5{-}Br$	301 (72)
$(CH_3)_2CH{-}Br$	309 (74)
$(CH_3)_3C{-}Br$	305 (73)
$CH_2{=}CHCH_2{-}Br$	247 (59)
$C_6H_5{-}Br$	351 (84)
$C_6H_5CH_2{-}Br$	263 (63)
$C{-}I$ bonds	
$CH_3{-}I$	242 (58)
$C_2H_5{-}I$	238 (57)
$(CH_3)_2CH{-}I$	238 (57)
$(CH_3)_3C{-}I$	234 (56)
$CH_2{=}CHCH_2{-}I$	192 (46)
$C_6H_5{-}I$	280 (67)
$C_6H_5CH_2{-}I$	213 (51)
$C{-}N$ single bonds	
$CH_3{-}NH_2$	355 (85)
$C_6H_5{-}NH_2$	435 (104)
$C{-}O$ single bonds	
$CH_3{-}OH$	385 (92)
$C_6H_5{-}OH$	468 (112)

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You will learn the secret structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 9/10/25

You will learn why when you take Advil for pain, exactly half of what you take works, and the other half does nothing. 9/24/25

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You will learn how to understand movies of reaction mechanisms like alkene hydration.

You will learn reactions that once begun, will continue reacting such that each product molecule created starts a new reaction until all the starting material is used up.

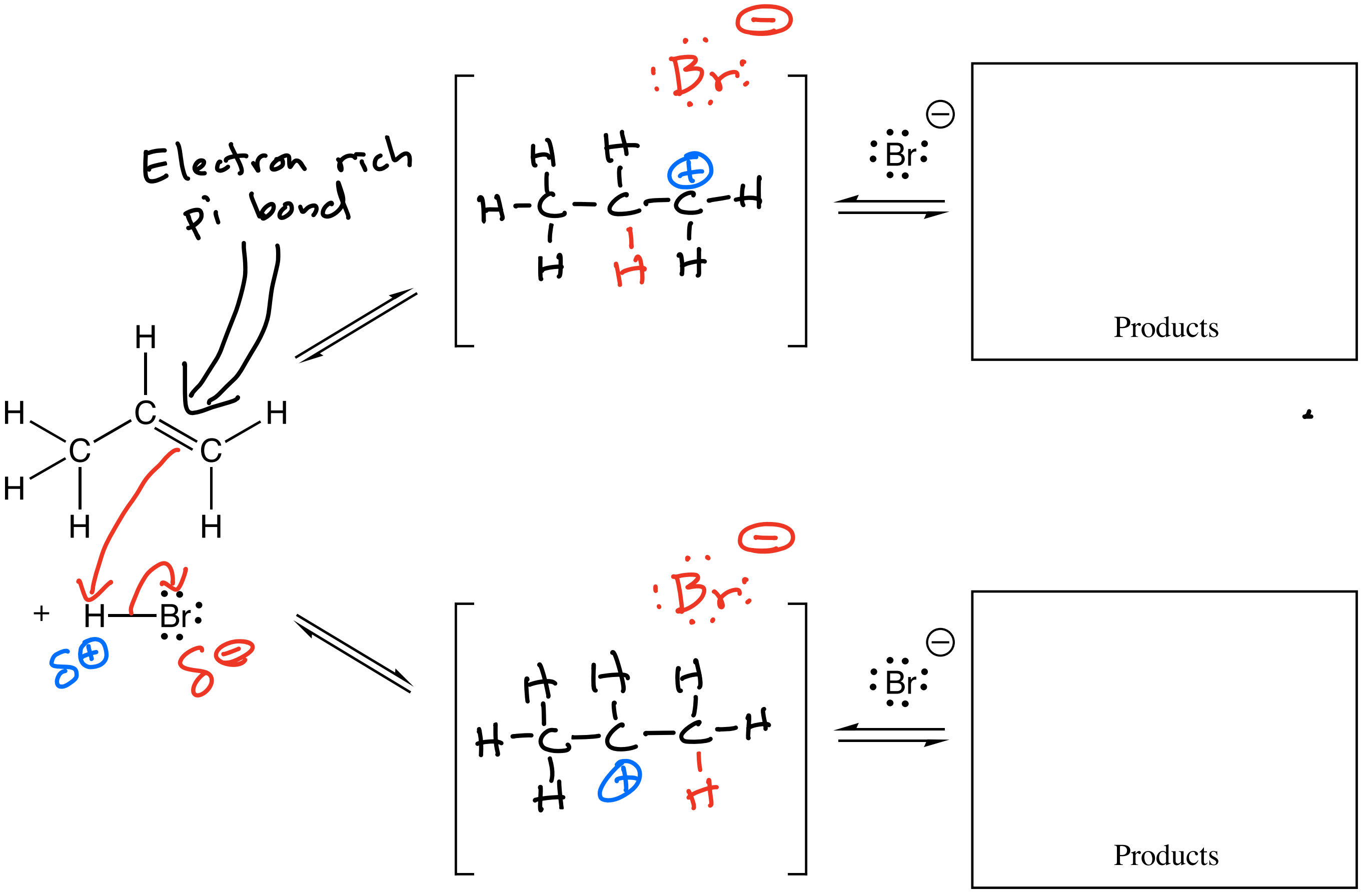
You will learn reactions that can make antifreeze from vodka.

You will learn a reaction that can make nail polish remover from rubbing alcohol.

You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.

You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.

Addition of H-X to an Alkene

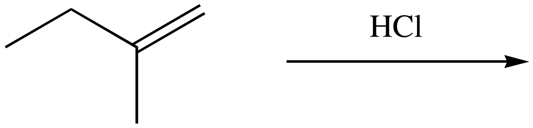


Summary:

Regiochemistry:

Stereochemistry:

Example:



For a reaction to take place, you need both:

Motive → thermodynamic driving force

* 1) Make stronger bonds than you break

2) Formation of a weaker acid (or base)

3) Entropy → if you make a gas molecule (H_2, N_2)

Opportunity → reasonable mechanism so that activation energy is not too high

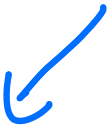
⇒ movement of electrons

Mechanisms → movement of electrons and
and atoms in chemical reactions

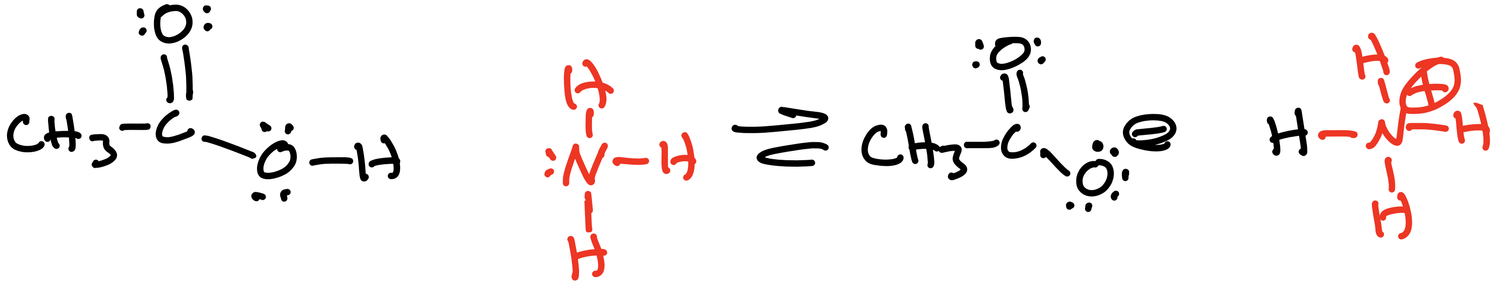
1) Arrows in reaction mechanisms

2) Arrows in reaction mechanisms

3) Arrows start at an
electron ______

and end at an
electron ______


4) Breaking a bond will occur

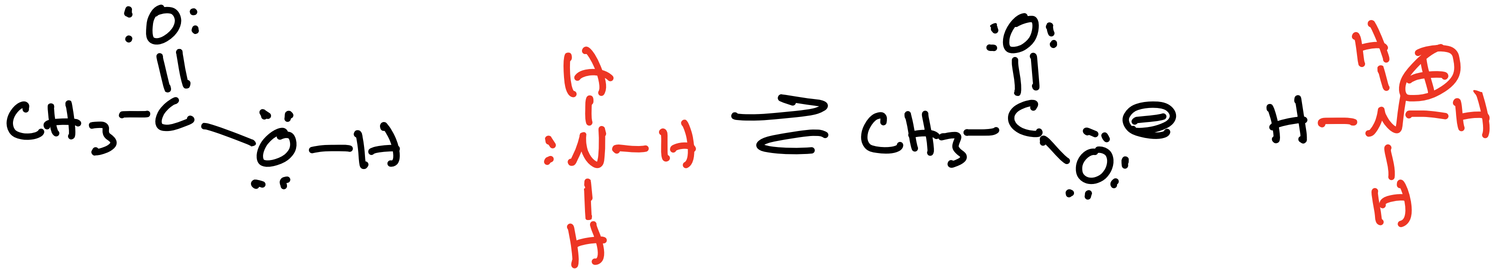


$$CH_3-C(=O)-OH + NH_3 \rightleftharpoons CH_3-C(=O)-O^{\ominus} + NH_4^{\oplus}$$

a) → lone pair on N atom

b) → OH sigma bond breaks

Mistake to avoid → moving an atom with an arrow



$$CH_3-C(=O)-OH + NH_3 \rightleftharpoons CH_3-C(=O)-O^{\ominus} + NH_4^{\oplus}$$

WRONG!! →

Nucleophile → electron rich species

↓

analogous to

a

Ex.

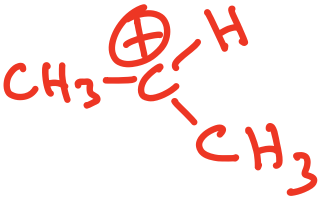
Electrophile → electron deficient species

↓

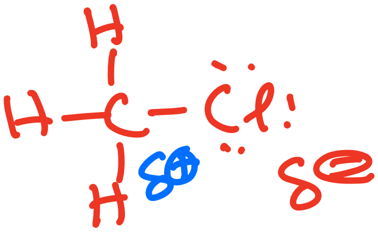
analogous to

a

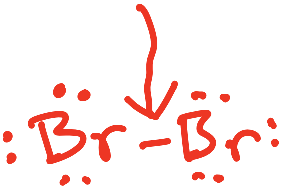
Ex. Full ⊕



Partial ⊕



Weak bond



The 4 Most Important Mechanistic Elements

The following are expressed from the point of view of the carbon-containing molecule taking part in a reaction

1) **Make a bond** between a nucleophile and electrophile.

⇒ A nucleophile and electrophile are both present

2) **Break a bond** to give stable molecules or ions.

⇒ None of the other possibilities are likely

3) **Add a proton**

⇒ Acid is present

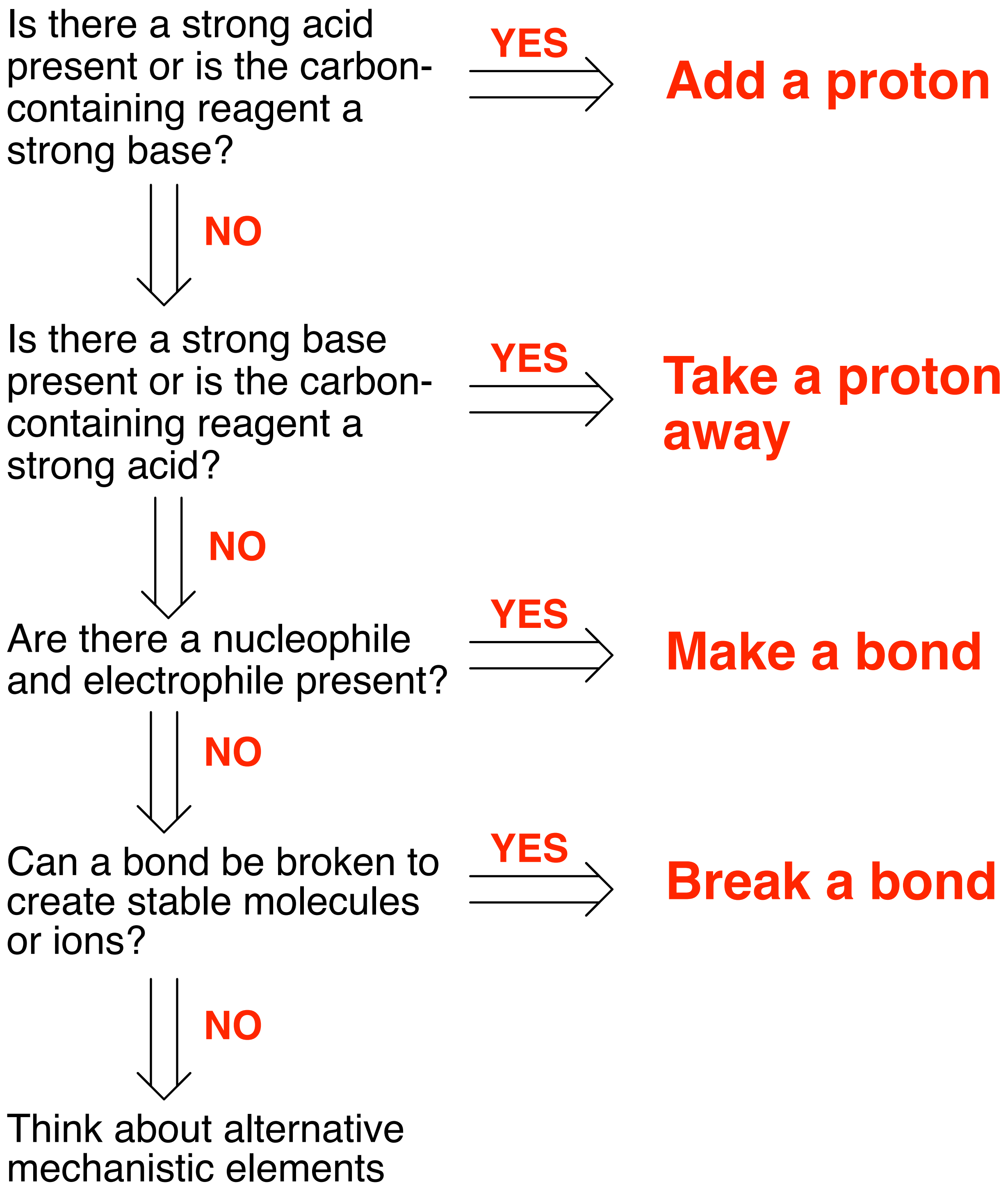
4) **Take a proton away**

⇒ Base is present

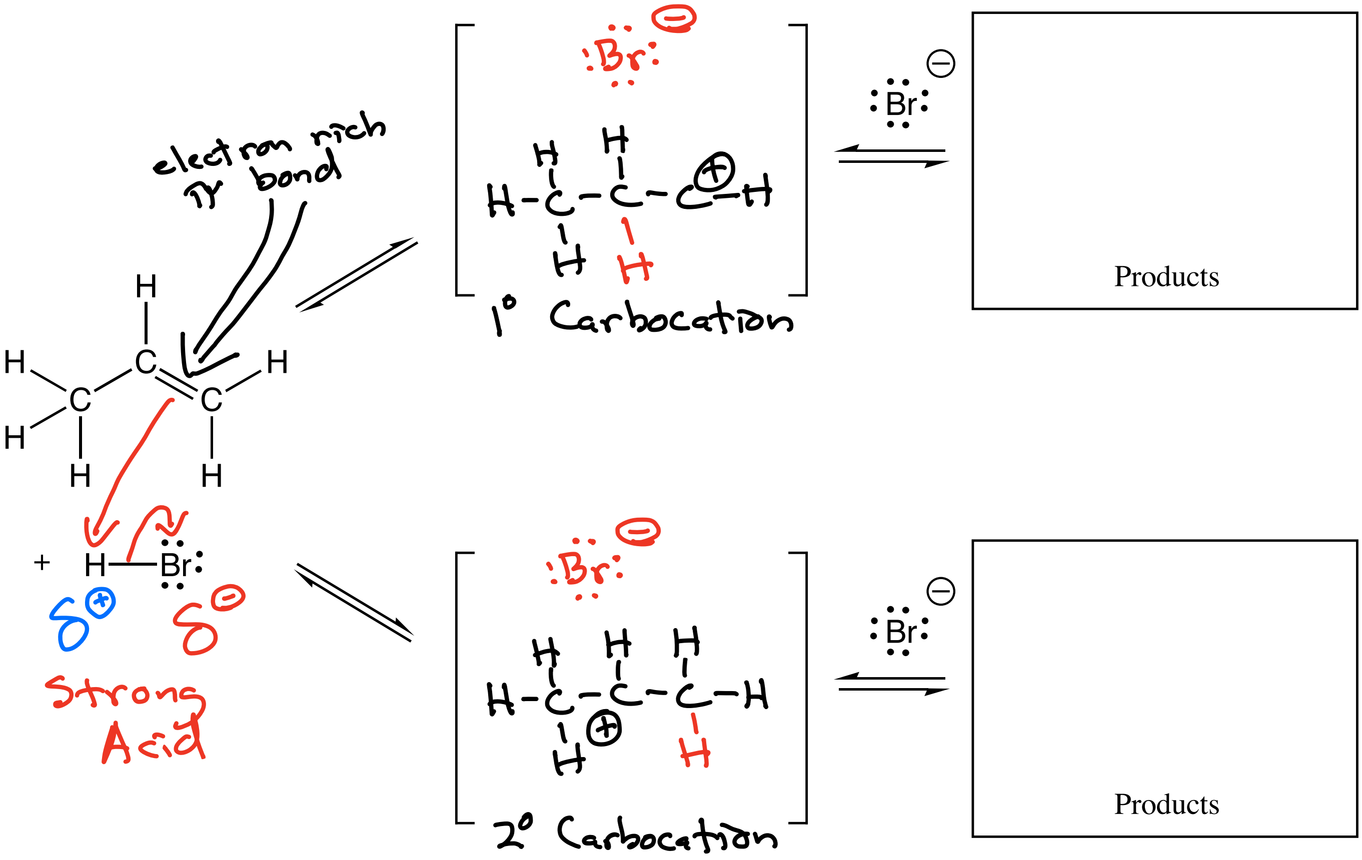
Notice →

Mechanism Summary

The following questions and mechanistic elements are described from the point of view of the carbon-containing reagent, written in the form of a flowchart.



Addition of H-X to an Alkene



Summary:

Regiochemistry:

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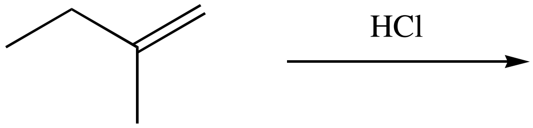
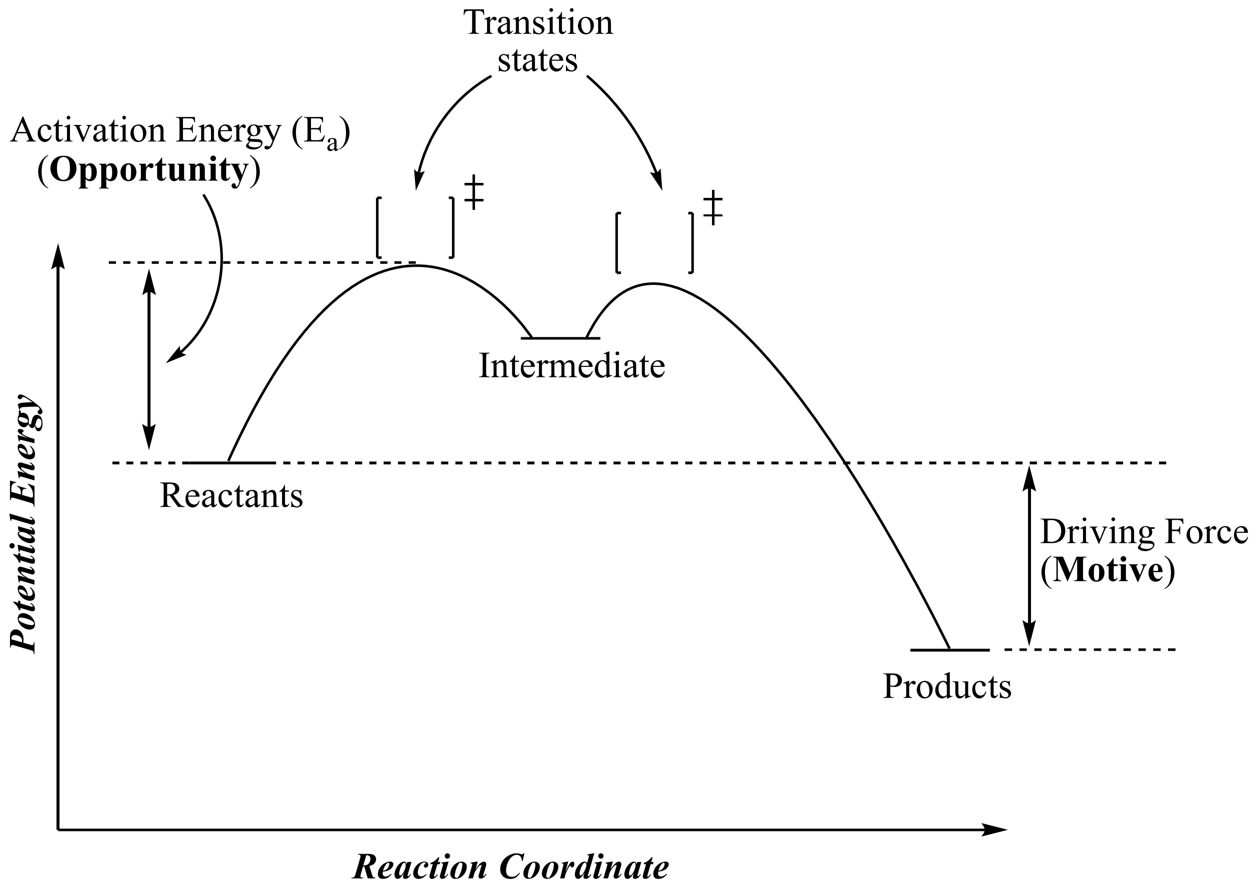
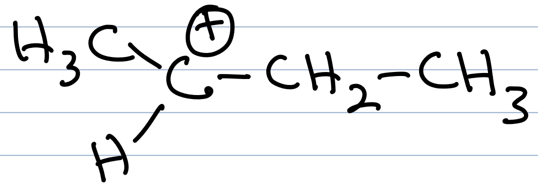




During reactions we often encounter intermediates

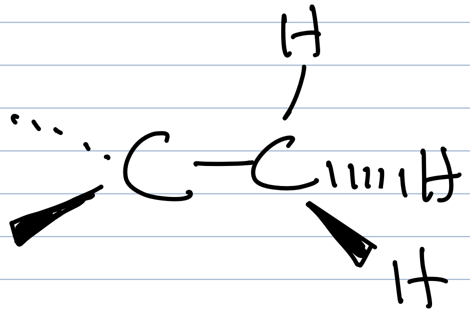
When alkenes react with H-X →

Carbocations →



Alkyl groups stabilize carbocations by 2 different mechanisms

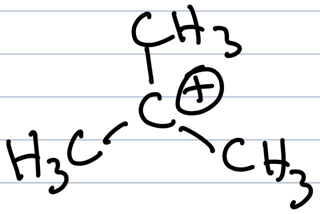
1) Hyperconjugation →

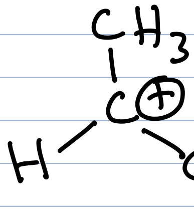


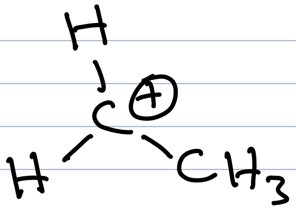
Some electron density of the C–H σ bond

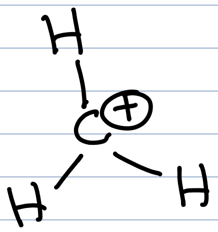
2) Inductive effect →

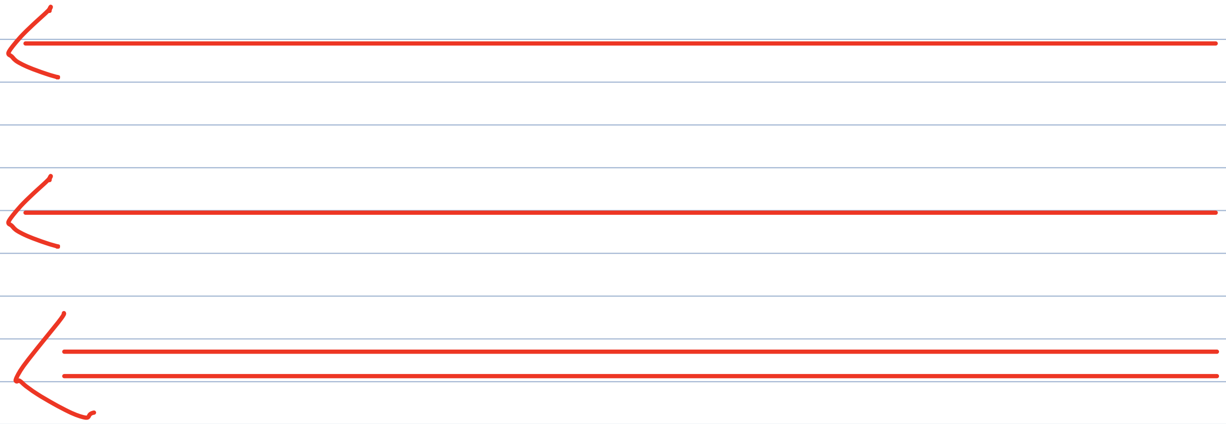
Carbocation stability →





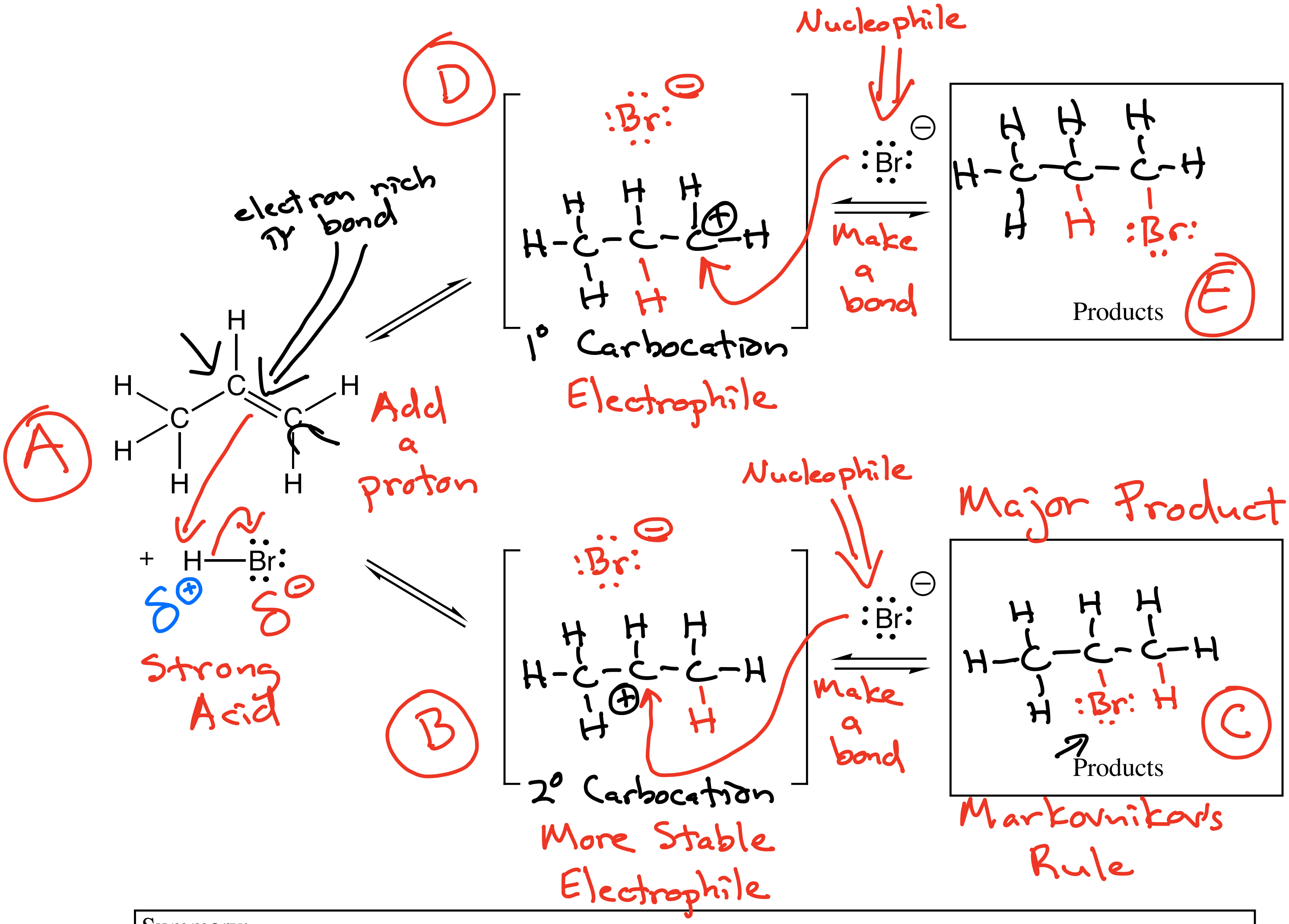






Addition of H-X to an Alkene

X = Cl, Br, I
but not F



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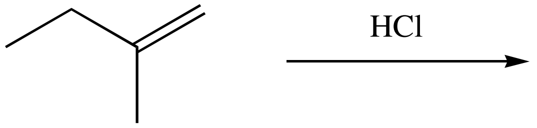

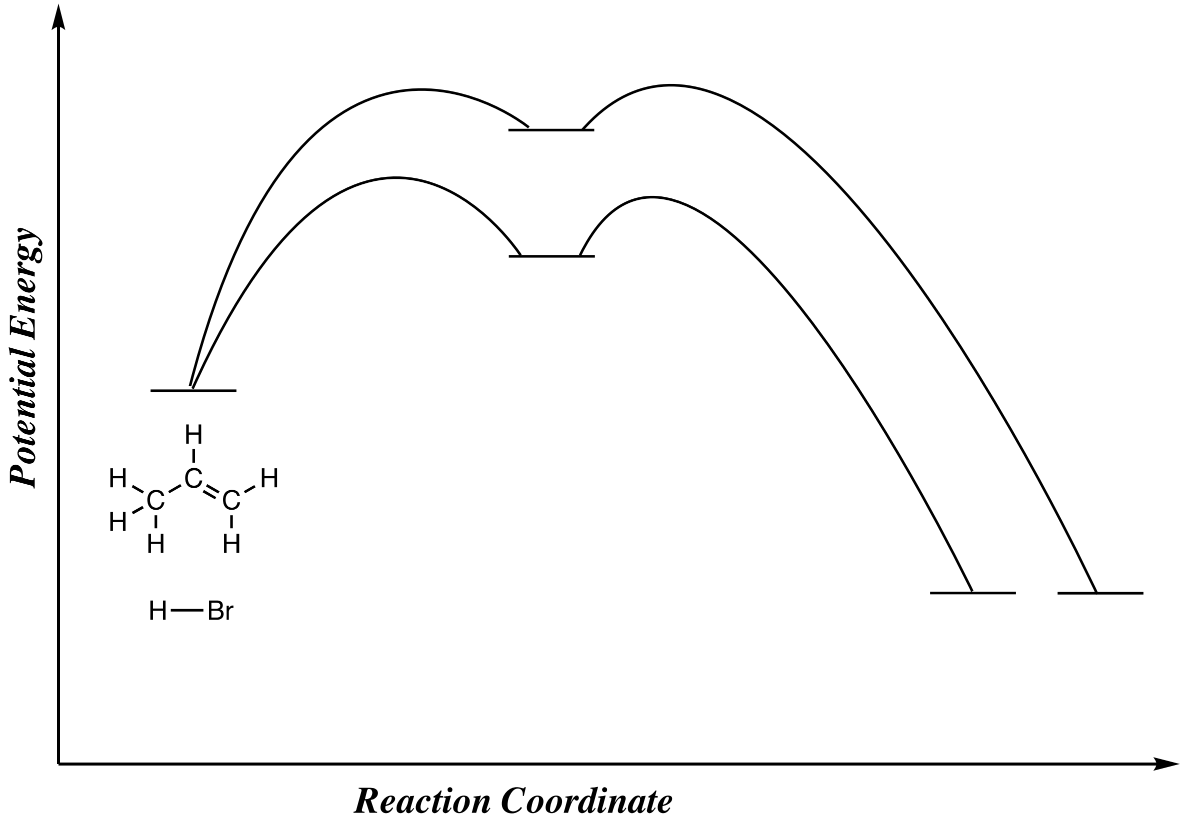

Creation of has a lower energy barrier and it forms faster → We get more product

Markovnikov's Rule → For alkene reactions involving a carbocation intermediate

Regiochemistry →

Stereochemistry → Which of the possible stereoisomers are formed?

Time capsule → The stereochemistry of H-X addition to an alkene is MIXED as H and X can end up on both the same (cis, syn) and opposite (trans, anti) sides of the original double bond

Addition of H-X to an Alkene

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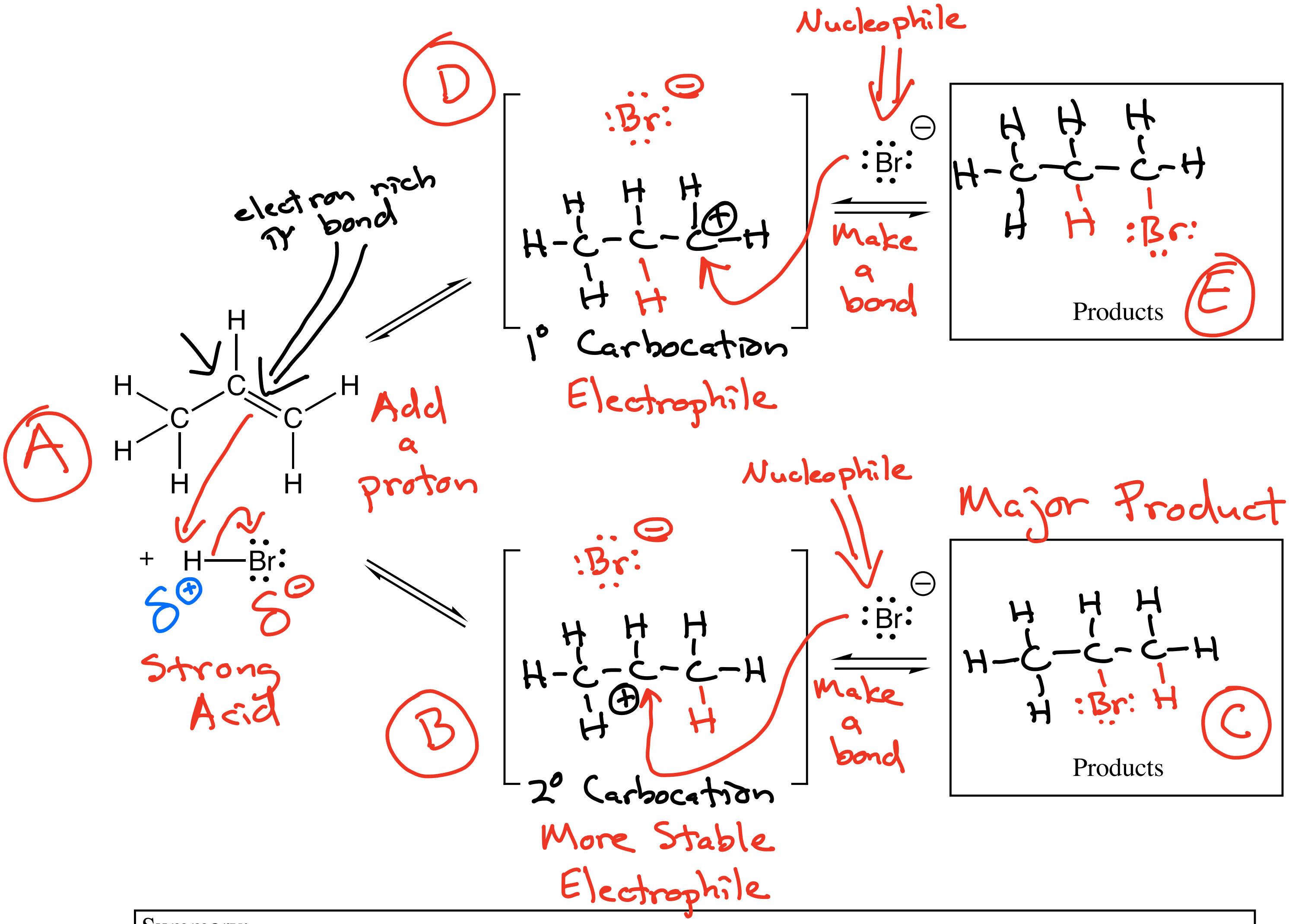

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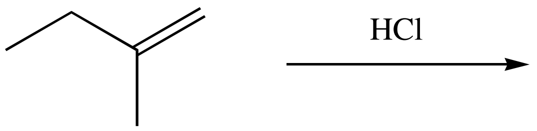
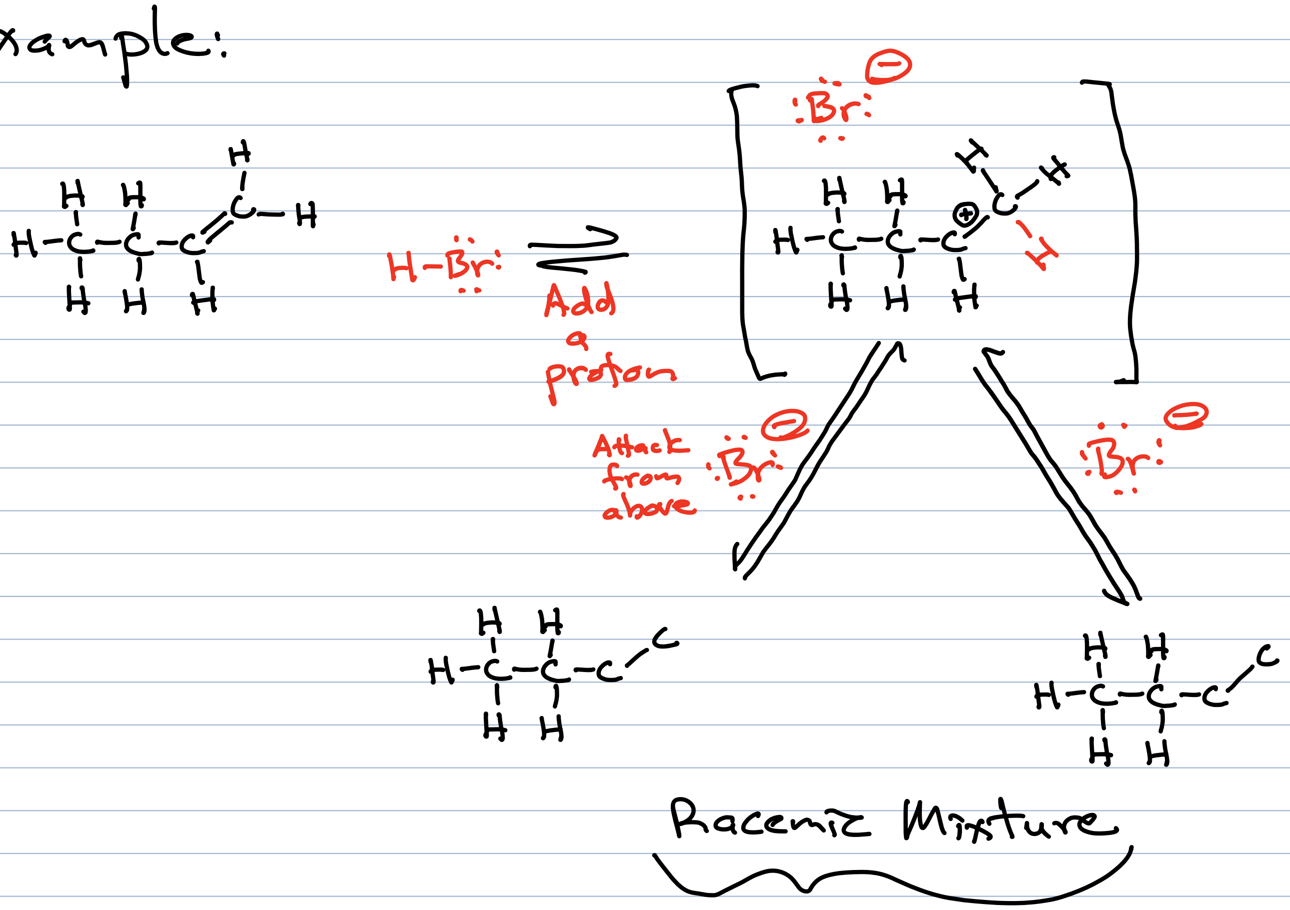
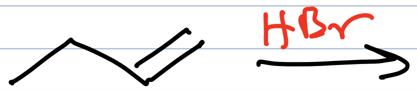


Chiral Example:

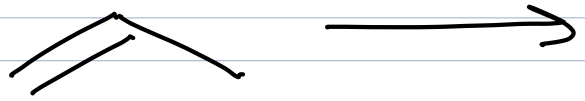


Also written as



New Reaction: → "same song, different verse"

Overview



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1) **Make a bond** between a nucleophile and electrophile.

⇒ A nucleophile and electrophile are both present and a bond can be made.

2) **Break a bond** to give stable molecules or ions.

⇒ None of the other possibilities are likely and the fragments produced are relatively stable

3) **Add a proton**

⇒ Acid is present or the molecule is a strong base.

4) **Take a proton away**

⇒ Base is present or the molecule is a strong acid.

Notice → 1) is the reverse of 2) and 3) is the reverse of 4) .... and vice versa

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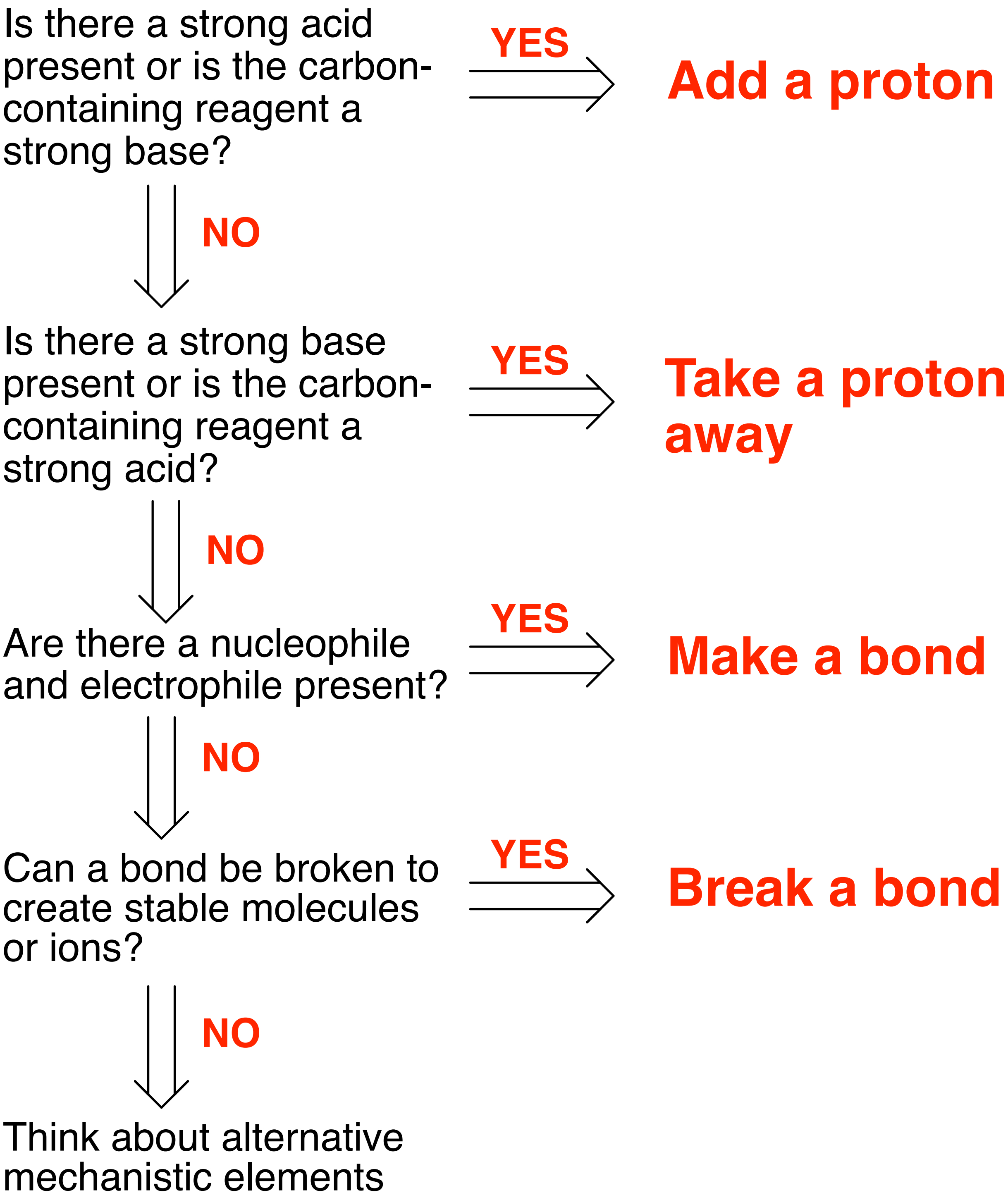


Is there a strong acid present or is the carbon-containing reagent a strong base? YES → **Add a proton**

NO ↓

Is there a strong base present or is the carbon-containing reagent a strong acid? YES → **Take a proton away**

NO ↓

Are there a nucleophile and electrophile present? YES → **Make a bond**

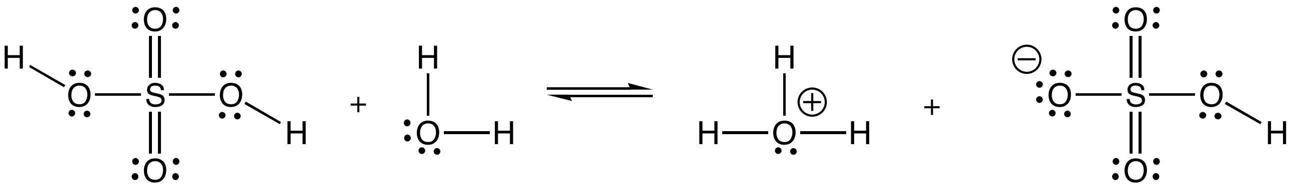
NO ↓

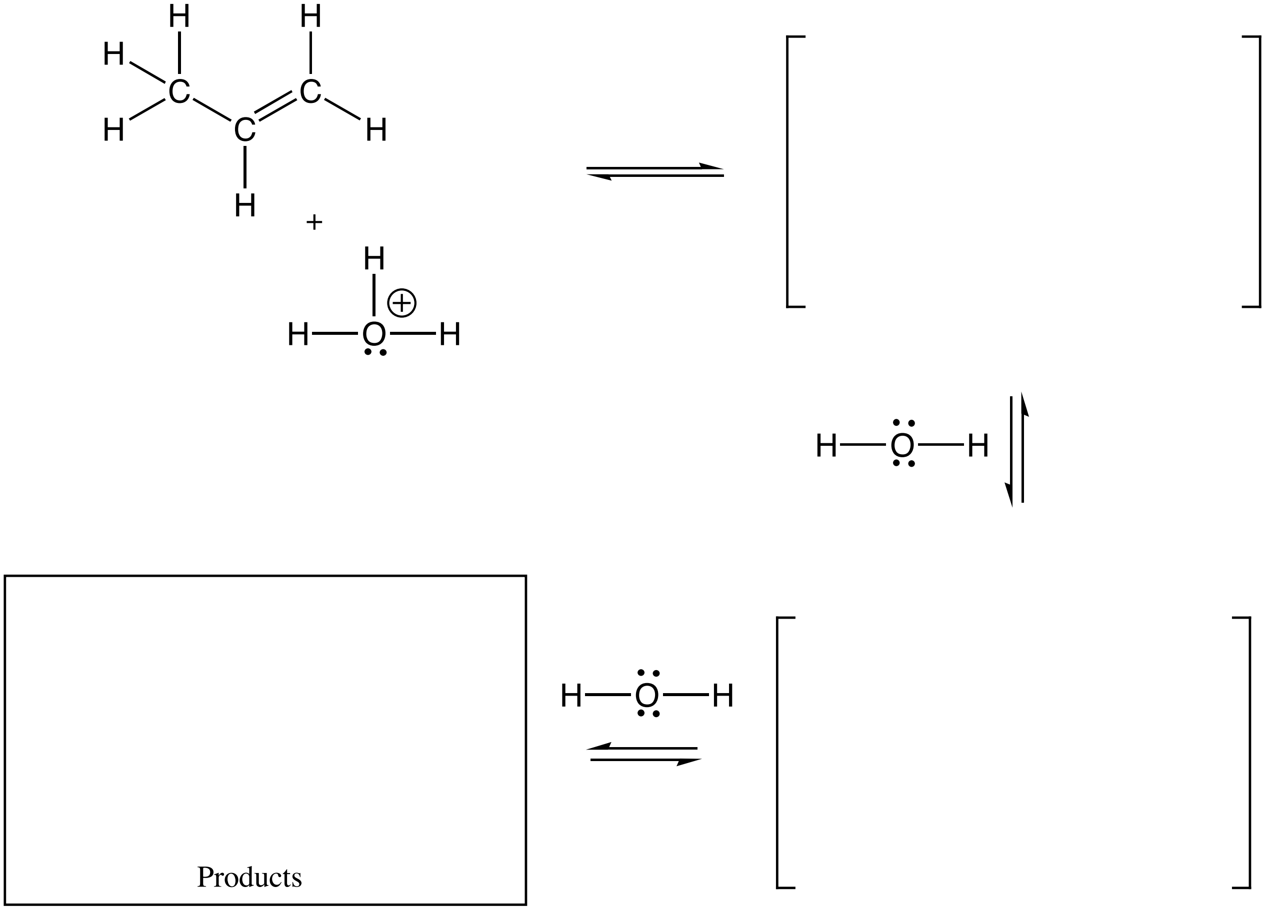
Can a bond be broken to create stable molecules or ions? YES → **Break a bond**

NO ↓

Think about alternative mechanistic elements

Acid-catalyzed Hydration of an Alkene





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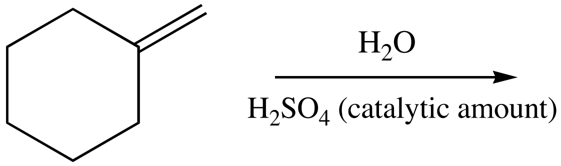

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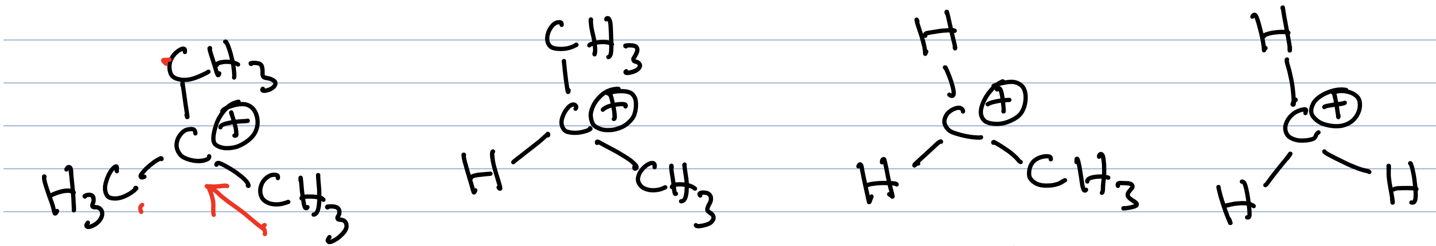
Carbocation stability → the more C atoms bonded to the $C^{\oplus}$ the more stable



3° (tertiary) 2° (secondary) 1° (primary) methyl

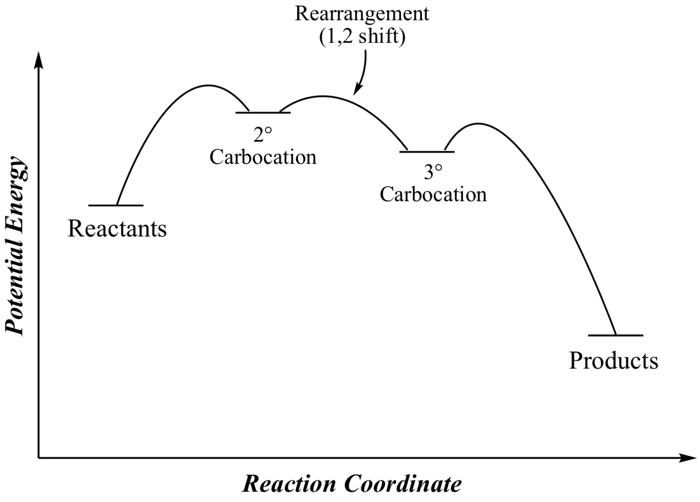
← Hyperconjugation stabilization

← Inductive effect stabilization

⇐ Carbocation Stability

Markovnikov's Rule → For alkene reactions involving a carbocation intermediate the nucleophile (ex. $:\ddot{\underset{\cdot\cdot}{Br}}:^{\ominus}$) will make a bond to the more substituted C atom → derived from the more stable carbocation

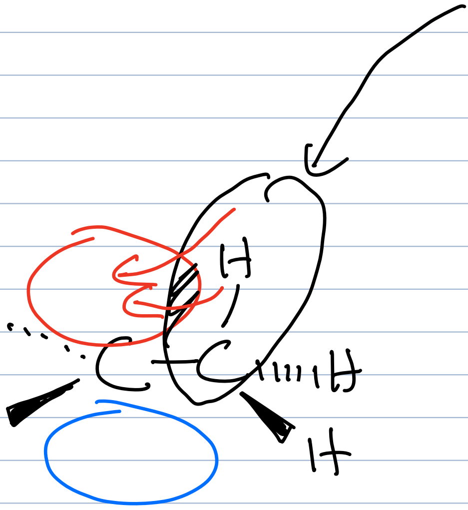
Carbocation intermediates can sometimes rearrange (Called 1,2 Shift)



Motive→

Opportunity →

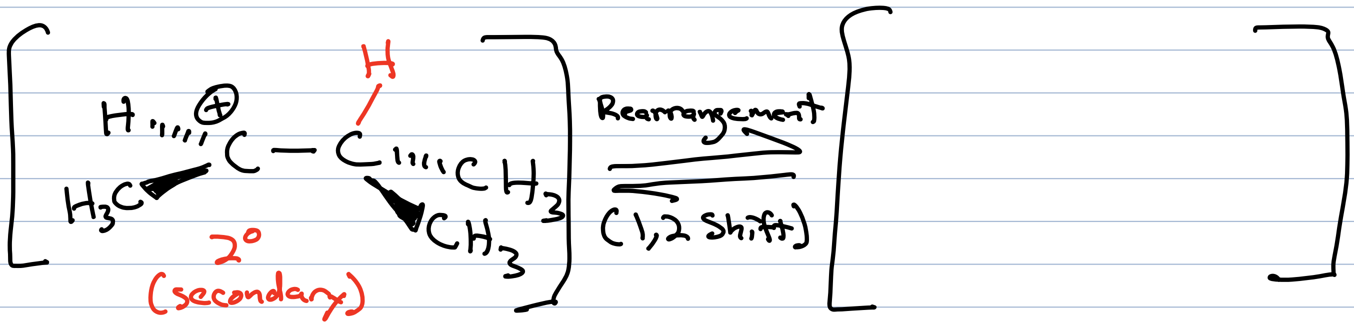
1) Hyperconjugation → overlap of adjacent σ bonding electron density with the empty 2p orbital of a carbocation



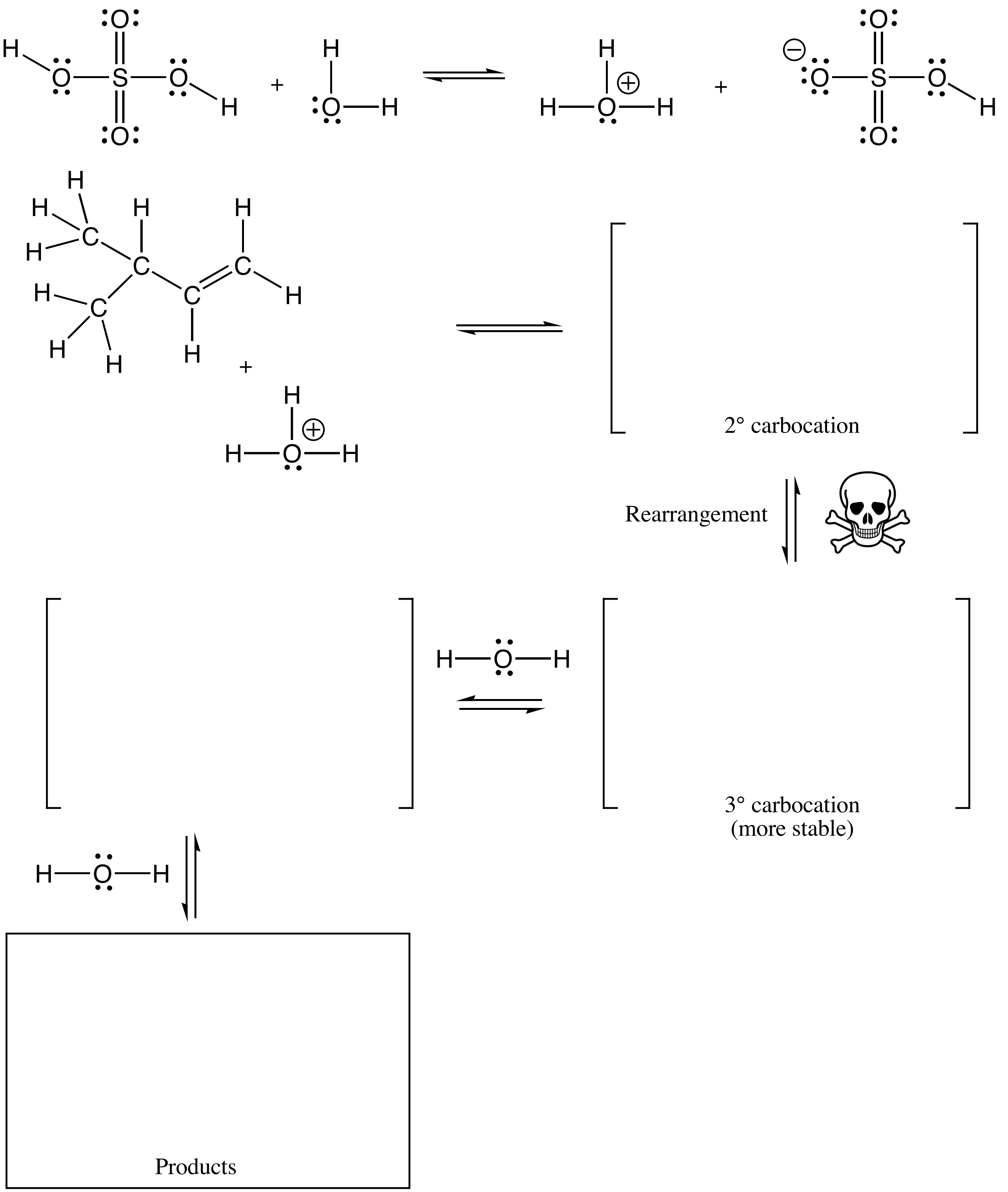
delocalizes the ⊕ charge

Some electron density of the C–H σ bond is pulled into the empty 2p orbital

(red arrows in the figure)



Cation Rearrangement



Example: