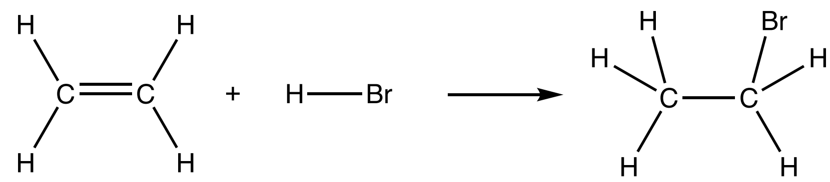
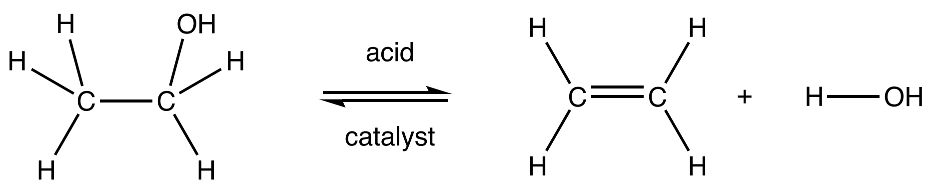
Kinds of Organic Reactions

Section 6.1

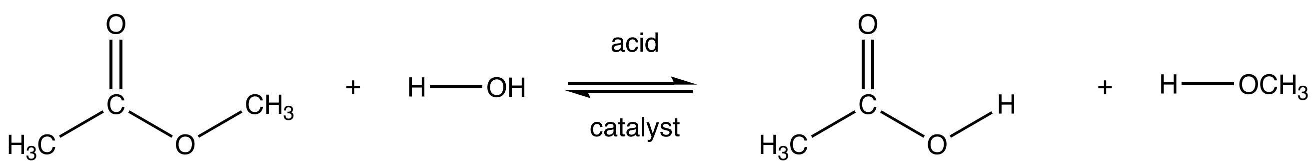
Addition Reactions



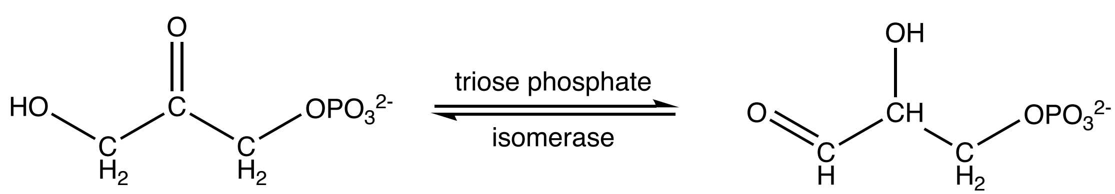
Elimination Reactions



Substitution Reactions

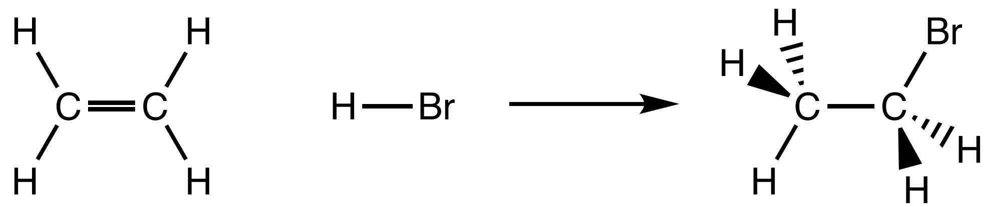


Rearrangement Reactions



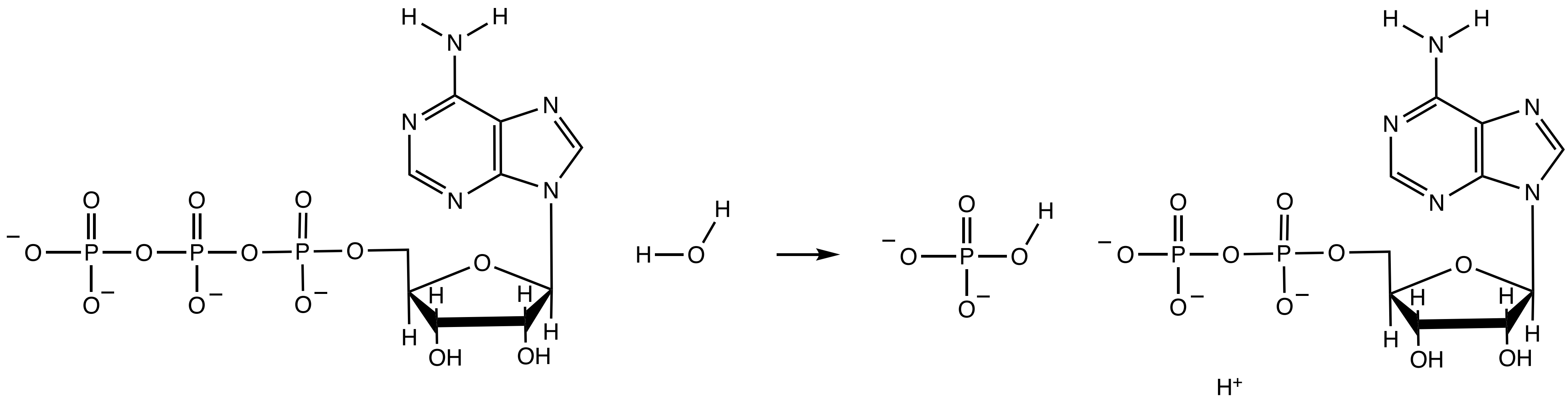
Bond Dissociation Enthalpies in kJ/mol[1]					
H—H	436	$(CH_3)_2CH$—H	410	CH_3CH_2—CH_3	370
H—F	570	$(CH_3)_2CH$—Cl	354	$(CH_3)_2CH$—CH_3	369
H—Cl	431	$(CH_3)_2CH$—Br	299	$(CH_3)_3C$—CH_3	363
H—Br	366	$(CH_3)_3C$—H	400	H_2C=CH—CH_3	426
H—I	298	$(CH_3)_3C$—Cl	352	H_2C=$CHCH_2$—CH_3	318
Cl—Cl	242	$(CH_3)_3C$—Br	293	H_2C=CH_2	728
Br—Br	194	$(CH_3)_3C$—I	227	C_6H_5—CH_3	427
I—I	152	H_2C=CH—H	464	$C_6H_5CH_2$—CH_3	325
CH_3—H	439	H_2C=CH—Cl	396	$CH_3C(O)$—H	374
CH_3—Cl	350	H_2C=$CHCH_2$—H	369	HO—H	497
CH_3—Br	294	H_2C=$CHCH_2$—Cl	298	HO—OH	211
CH_3—I	239	C_6H_5—H	472	CH_3O—H	440
CH_3—OH	385	C_6H_5—Cl	400	CH_3S—H	366
CH_3—NH_2	386	$C_6H_5CH_2$—H	375	CH_3CH_2O—H	441
CH_3CH_2—H	421	$C_6H_5CH_2$—Cl	300	$CH_3C(O)$—CH_3	352
CH_3CH_2—Cl	352	C_6H_5—Br	336	CH_3CH_2O—CH_3	355
CH_3CH_2—Br	293	C_6H_5—OH	464	NH_2—H	450
CH_3CH_2—I	233	HCC—H	558	H—CN	528
CH_3CH_2—OH	391	CH_3—CH_3	377	H_2C=CH_2 π bond	273[2]

[1]Unless otherwise indicated values are from *Organic Chemistry: a 10th Edition*, McMurry, OpenStax, 2024
[2]JoC Vol. 89, Issue 20, 18 October 2024, Pages 15158-15163



Bond Dissociation Enthalpies in kJ/mol[1]					
H—Br	366	CH_3CH_2—Br	293		
$H_2C=CH_2$ π bond	273	CH_3CH_2—H	421		

Describing a Reaction: Bond Dissociation Energies



$\Delta H° = -30$ kJ/mol

Gibbs Free Energy

$$\Delta G° = \Delta H° - T\,\Delta S°$$

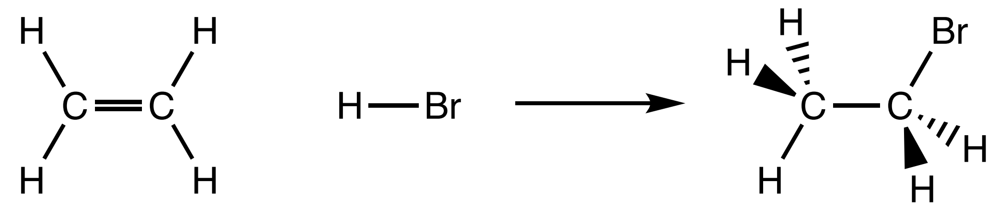
The Equilibrium Constant

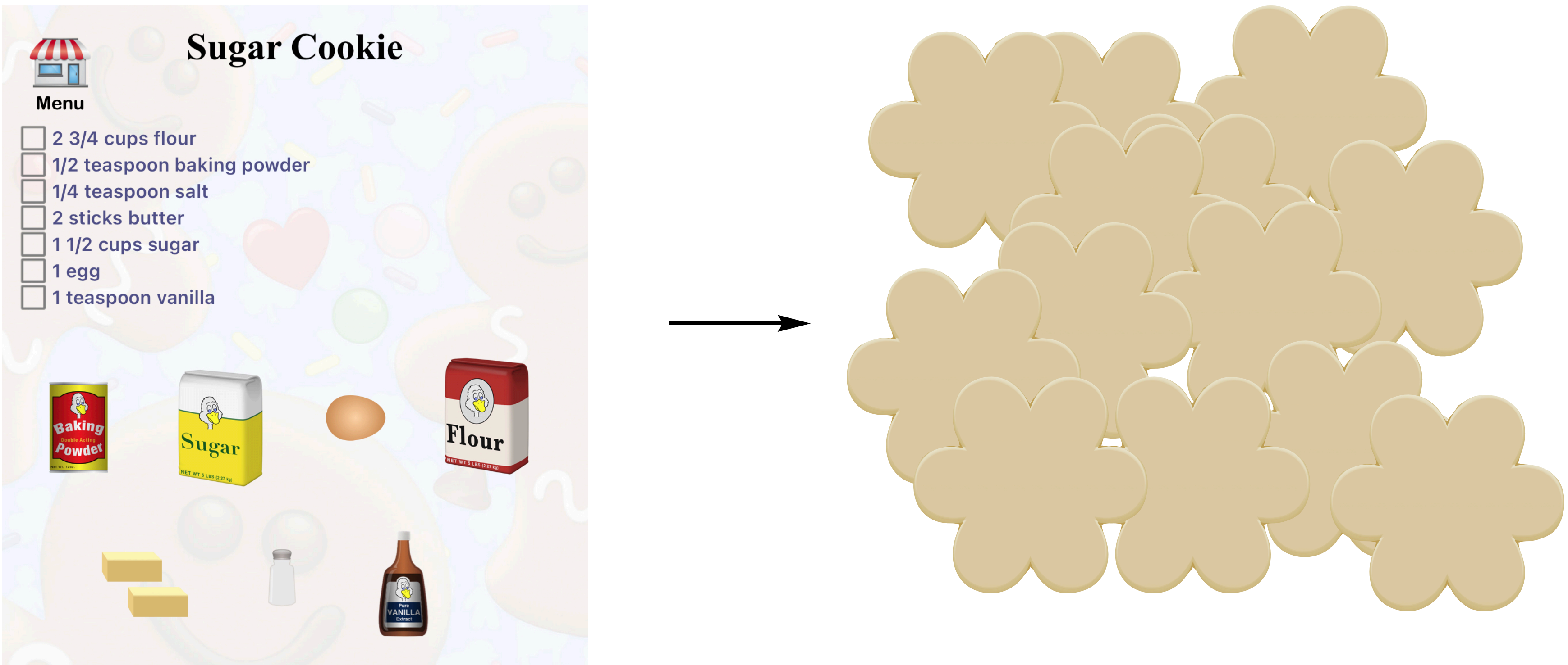
Gibbs Free Energy and the Equilibrium Constant

$$\Delta G^\circ = -\,RT\ \ln K_{eq}$$

relationship between equilibria and energy changes and rates

Balanced chemical equations are like ingredient lists

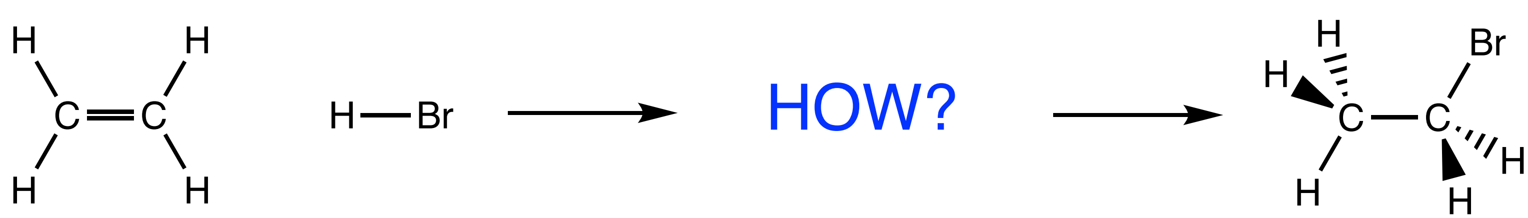




*CookieDoodle https://apps.apple.com/us/app/cookie-doodle/id342128086

Mechanisms are like the instructions

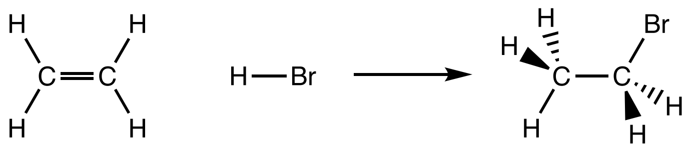
1. Cream the butter and sugar: beat together the butter and sugar with an electric mixer (hand-held or stand mixer) until the mixture is light and fluffy.
2. Add eggs and vanilla
3. Add flour, baking powder, and salt: Measure these dry ingredients into a separate bowl, whisk them together thoroughly, then turn your mixer to a lower speed and stir the flour mixture into the butter and sugar mixture.
4. Cover the dough with plastic wrap and refrigerate for at least one hour.[1]

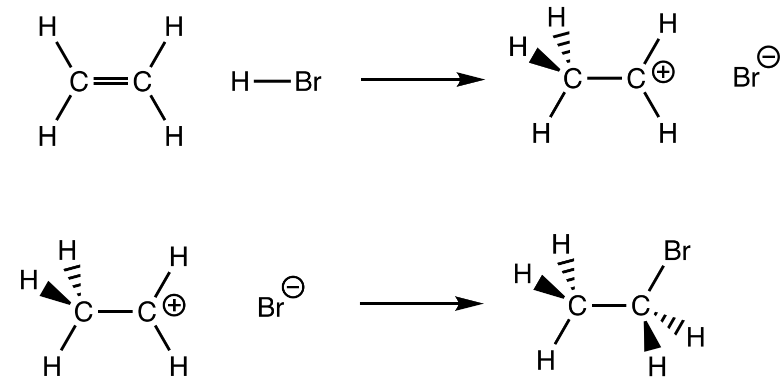


[1] https://www.allrecipes.com/recipe/10402/the-best-rolled-sugar-cookies/

Reaction Coordinate Diagrams

Section 6.9, 6.10





Reactant(s)

Product(s)

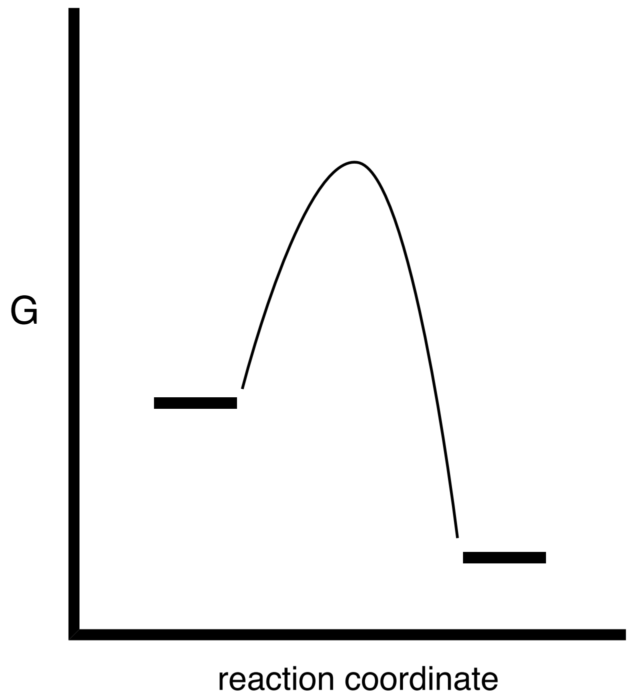
Transition State(s)

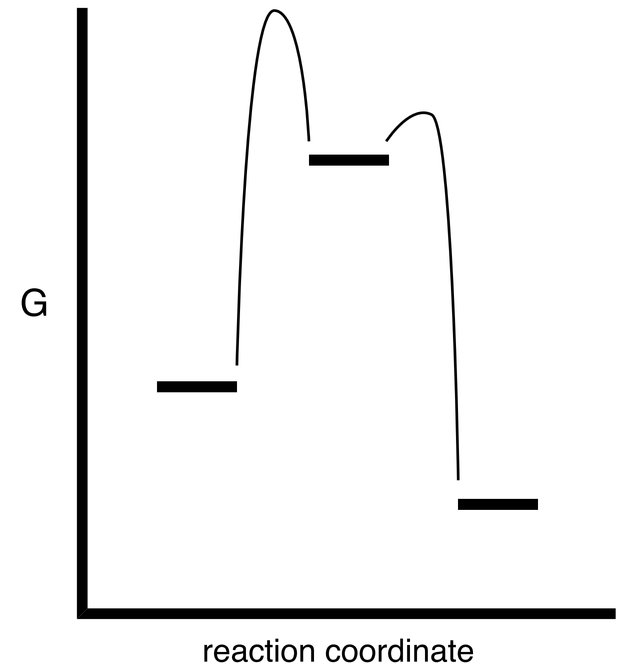
Intermediate(s)

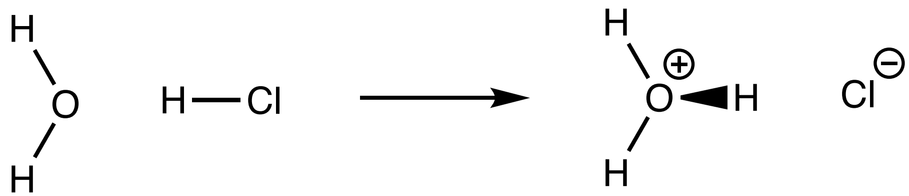
Activation Energy $\Delta G^{\ddagger}$
rate of a reaction
(kinetics)

ΔG (thermodynamics)

K (thermodynamics)



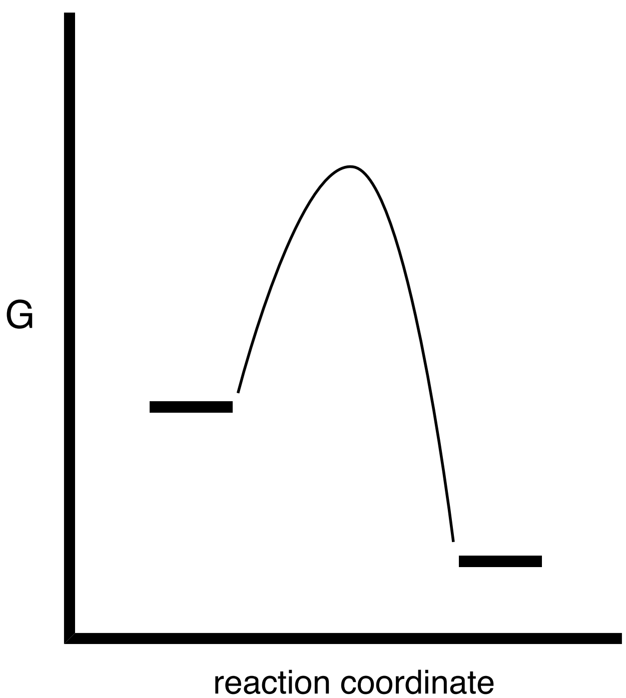




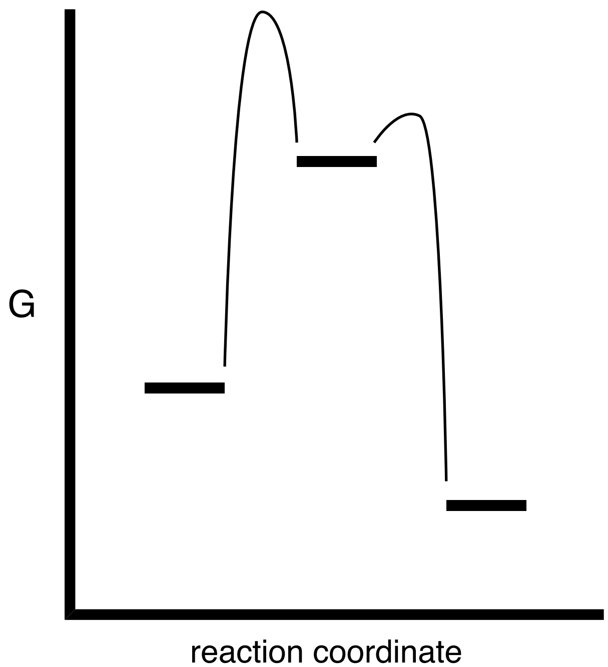
Reaction Coordinate Diagrams: Transition STates and the Hammond Postulate

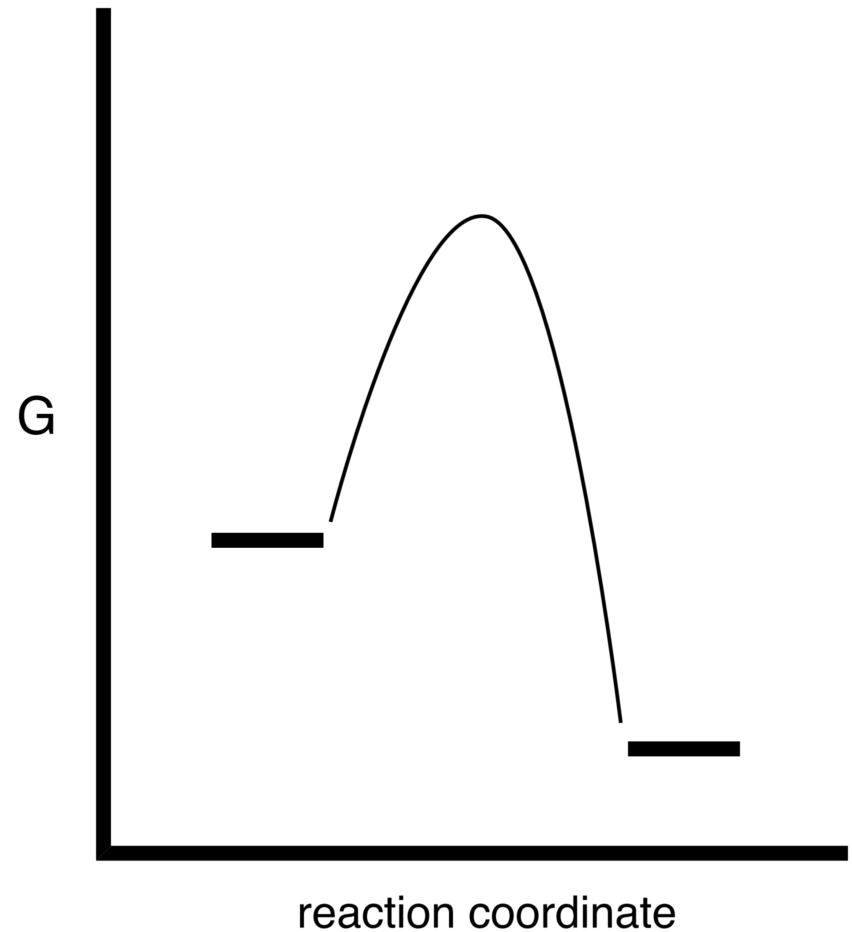
Section 6.9, 6.10, 7.10

Transition State(s)



Intermediate(s)




G
reaction coordinate

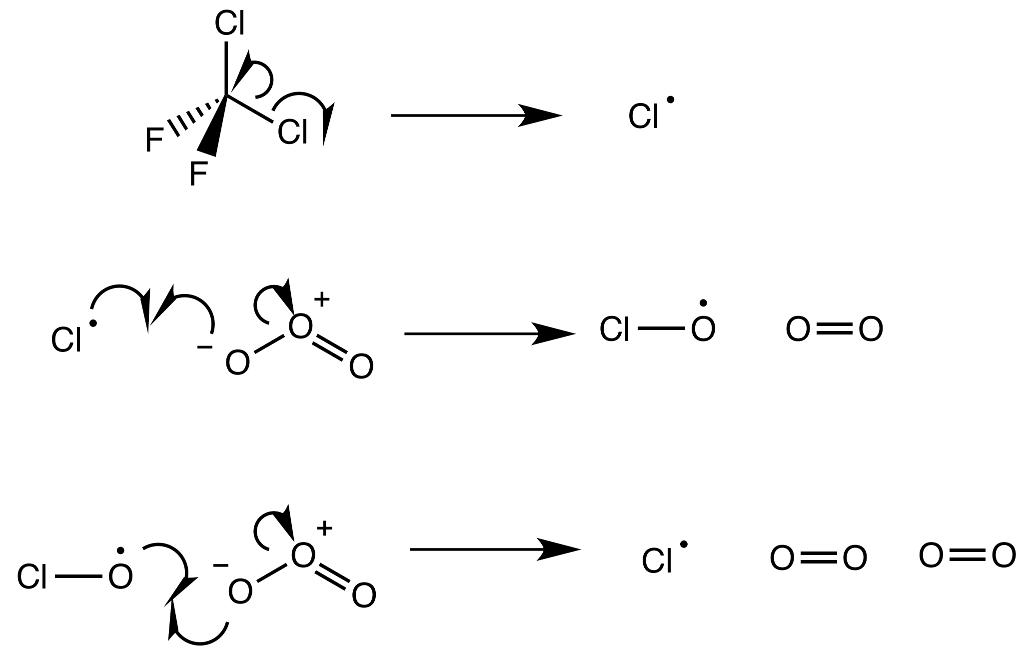
Homolytic Cleavage

Heterolytic Cleavage

Radical Bond Formation

Polar Bond Formation

Radical Chain Reactions in Environmental Chemistry
ozone depletion



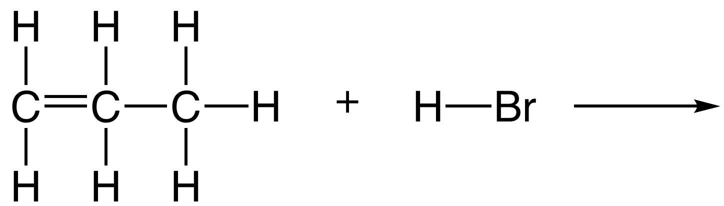
Opposites Attract

$H_3C—Li$ $Cl—CH_3$

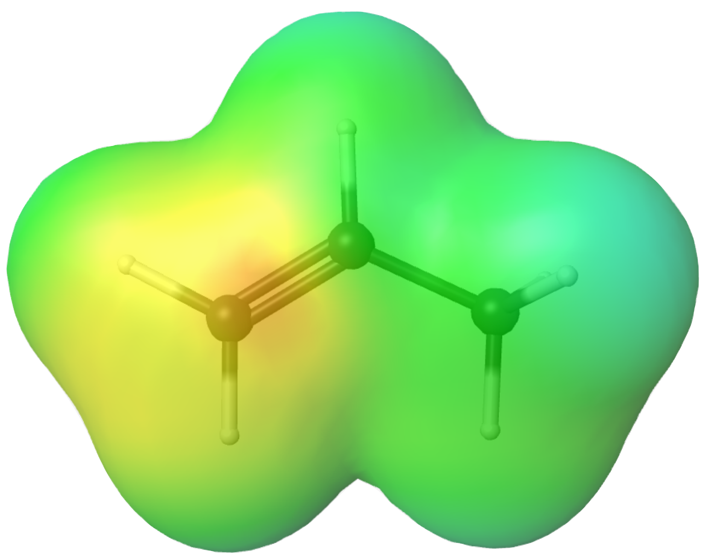
Bonds can be made more polar

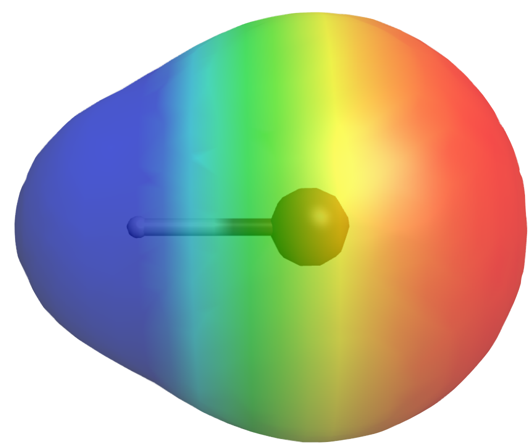
Polarizability makes polar reaction possible too

An Example of a Polar Reaction: Addition of HBr to Propene



What’s wrong with this structure?





Using Curved Arrows in Polar Reaction Mechanisms: Addition of HBr to H_2O

Section 6.5

Using Curved Arrows in Polar Reaction Mechanisms: Addition of HBr to Propene

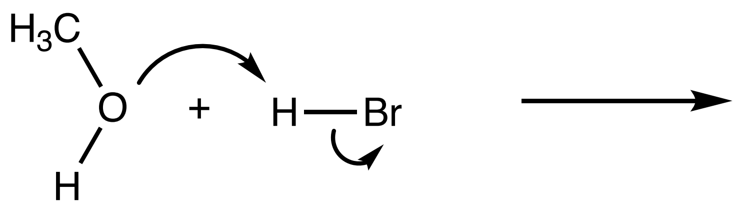
Section 6.5

Draw a reaction coordinate diagram for a one-step mechanism that has an unfavorable ΔG (a small K) and a large activation energy

Step 1: Identify the electrons that the arrow is starting at

Step 2: Describe what the electrons are doing: making a bond, or becoming a lone pair

Step 3: Draw the result.



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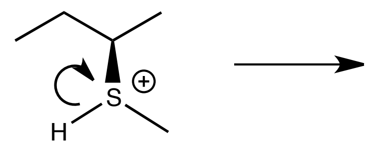

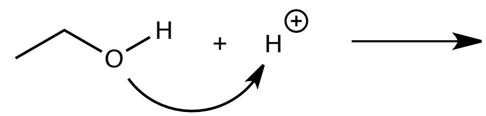

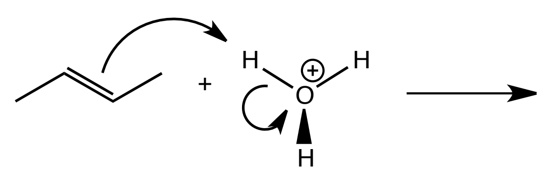

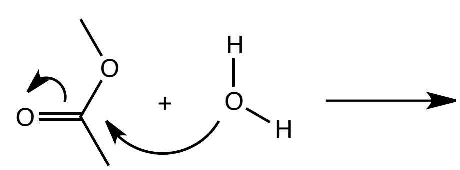

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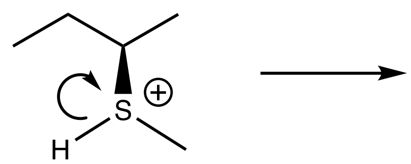

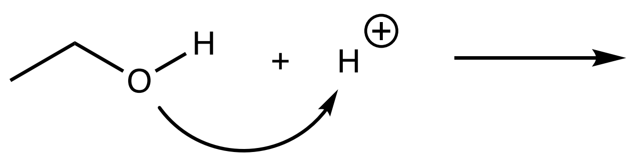

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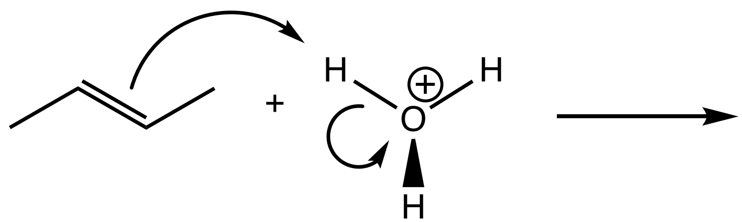
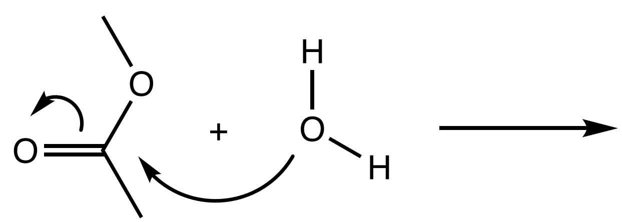
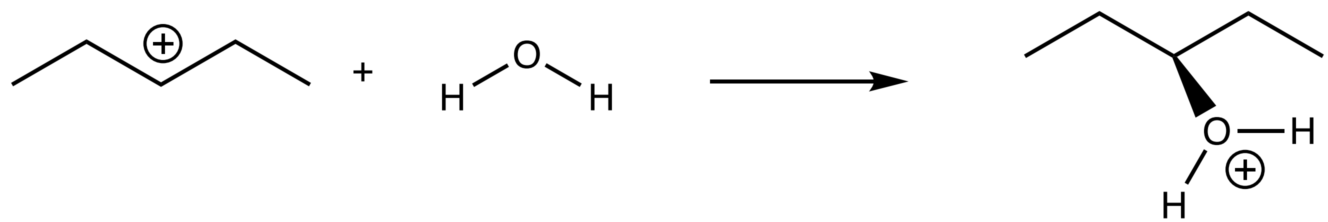




Step 1: Find bonds that are forming, bonds that are lost, or changes in charge

Step 2: find the electrons to move.

Step 3: Draw the arrows.



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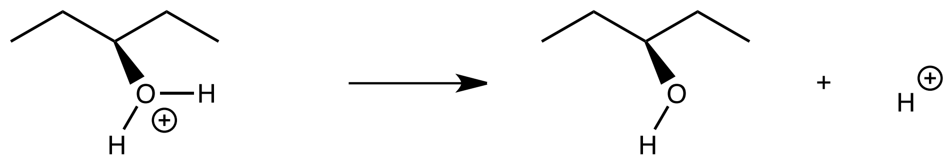

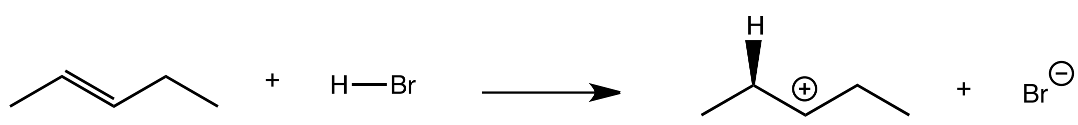

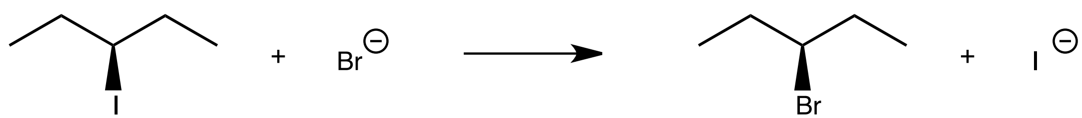

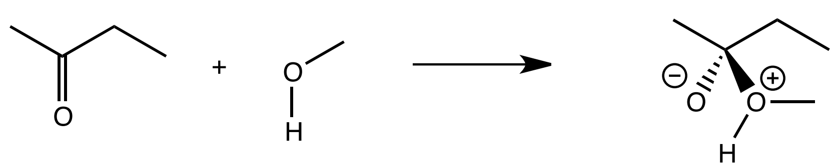

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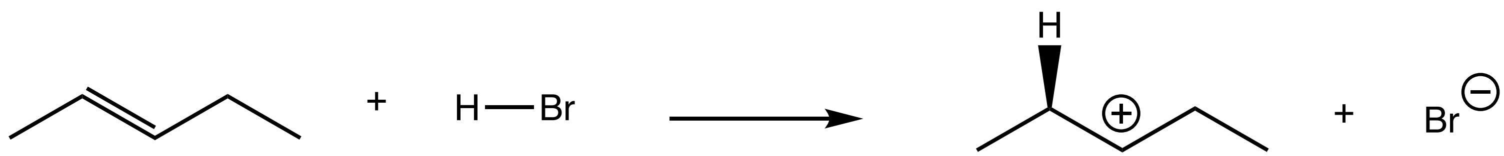

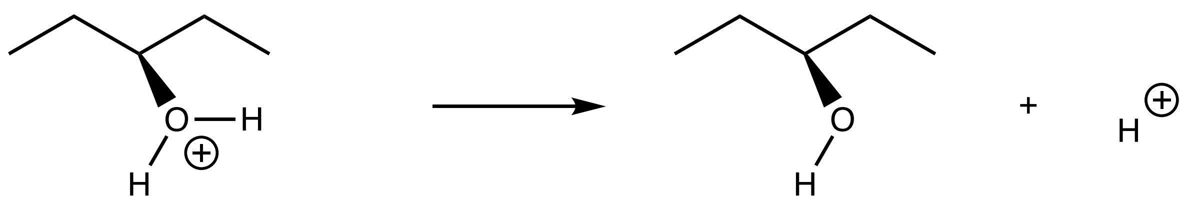

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