

Today

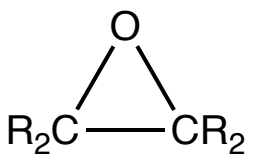
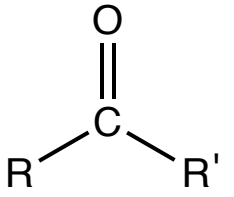
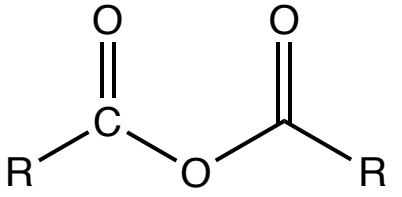
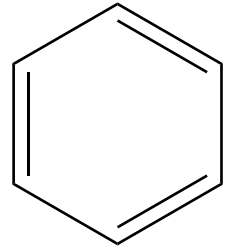
Next Class

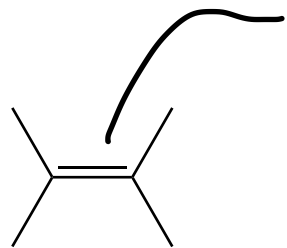
Sections 5.5 - 5.13  
How alkenes react

Kinetics, thermodynamics, reaction coordinate  
diagrams, and catalysis

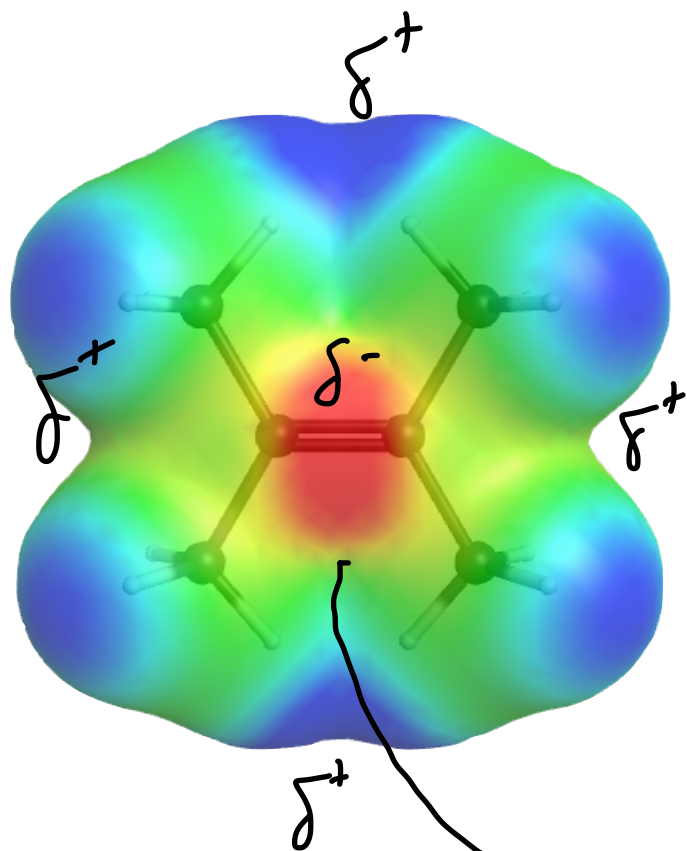
Section 6.1 and 6.2  
Electrophilic Addition and Carbocation Stability

Wilson 304 tonight 8 to 9:30

Group I	Group II	Group III	Group IV
<p><math>R_2C=CR_2</math> alkenes</p> <p><math>R-C\equiv C-R</math> alkynes</p>	<p><math>R_3C-X</math> X = Cl, Br, I Alkyl Halides</p> <p><math>R_3C-OH</math> alcohols</p> <p><math>R_3C-O-CR_3</math> ethers</p> <p> epoxides and more...</p>	<p> ketones (R, R' ≠ H) and aldehydes (R or R' = H)</p> <p><math>RC(=O)NR_2</math> amides</p> <p><math>RC(=O)OR'</math> esters (R' ≠ H)</p> <p><math>RC(=O)OH</math> carboxylic acids</p> <p> anhydrides</p> <p><math>RC(=O)Cl</math> acid chlorides</p>	<p> aromatics and more...</p>



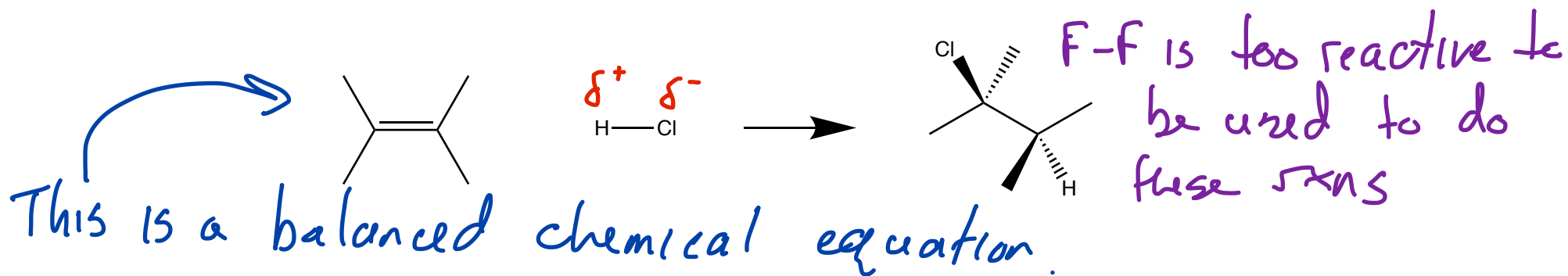
$sp^2$  hybridized C atoms form  $\sigma$  bond  
between two C atoms of the db  
the second bond of the db is  
made from overlapping unhybridized  
p orbitals



- p orbital stick out away from  
the nuclei  
-  $e^-$ 's in  $\pi$  bonds are not tucked  
down in between the nuclei  
like  $e^-$ 's in  $\sigma$  bonds are  
this is showing us that  $\pi$  bonds have  
an  $e^-$  rich area

Nucleophiles - nucleus loving because they are  $e^-$ -rich

Electrophiles - electron loving because they are  $e^-$ -deficient



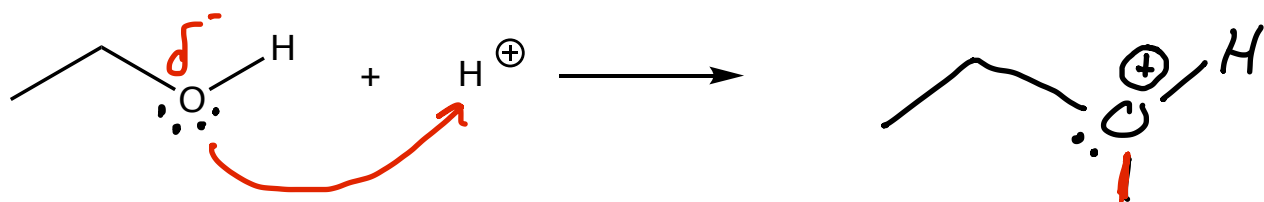
Balanced chemical equations are like an ingredient list in a recipe.

A mechanism is a hypothesis that explains the steps that occur to go from reactant to product... with experimental support the mechanism can become accepted theory

Arrow Pushing is not the mechanism. Helps us think of possible mechanisms. Can help us keep track of bonds that are breaking + forming.

Section 5.5

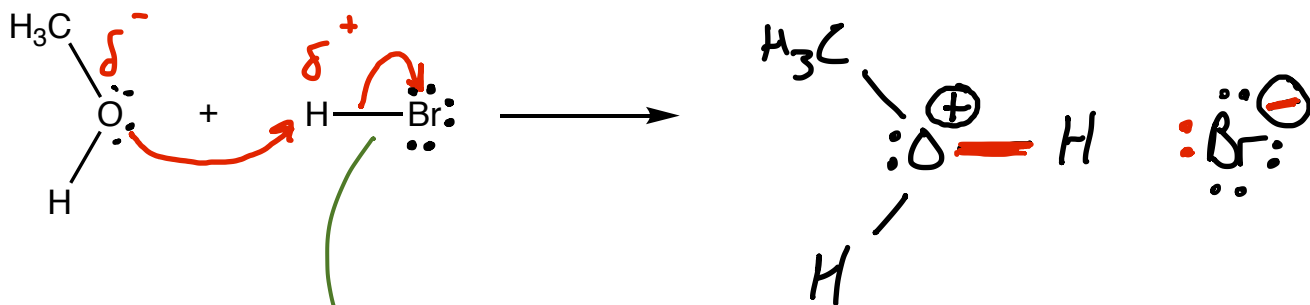
Arrows represent the imagined movement of electrons. In organic, arrows are **not** used to move atoms.



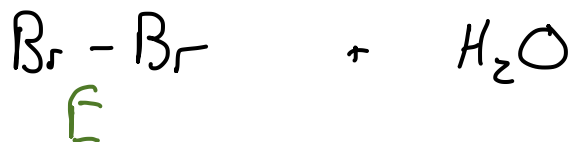
lone-pair  $e^-$  are forming a bond to the  $H^+$

$$FC_{Br} = 7 - (6 + 1) = 0$$

$$FC_{Br} = 7 - (8) = -1$$



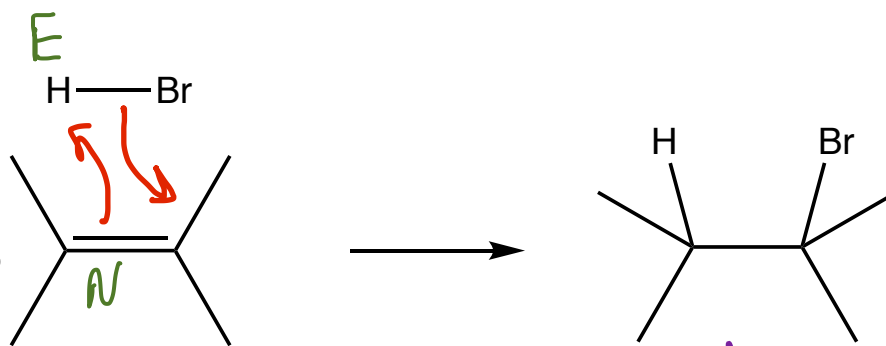
to make a bond to  $H^+$   
we will have to break the  $H-Br$  bond



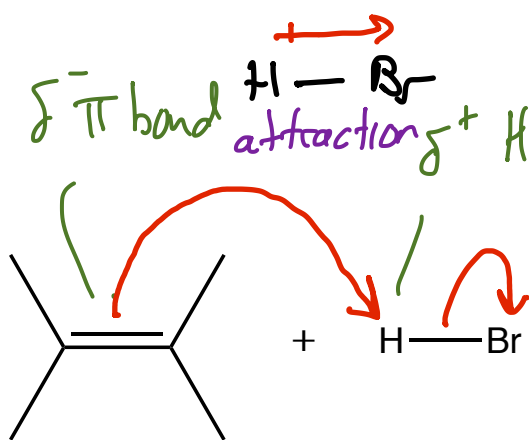
Arrows represent the imagined movement of electrons. In organic, arrows are **not** used to move atoms.

This is a proposed mechanism.

In 1 step reactants are converted to products



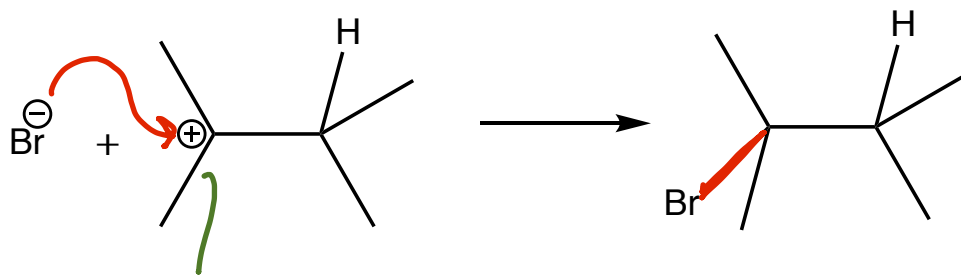
not the correct mechanism



there used to be a  $\pi$  bond here.  $e^-$  are lost

this are the  $e^-$ 's that used to be in the  $\pi$  bond.

nucleophilic  $\text{Br}^-$  ion

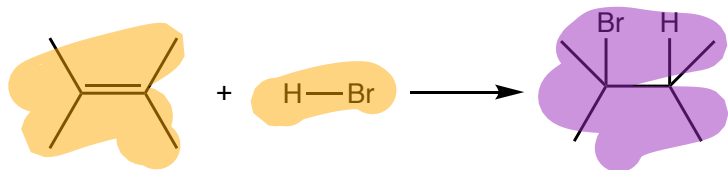


This C atom didn't lose  $e^-$ 's

this carbocation is an unstable electrophile

# Mechanism and Reaction Coordinate Diagrams

$\Delta G^\circ = -RT \ln K$   $K$  is equilibrium constant  
 Section 5.5  
 $\oplus = \ominus \cdot \ln(<1)$  constant

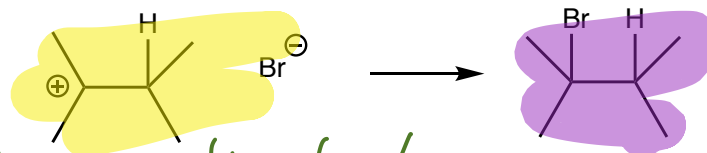
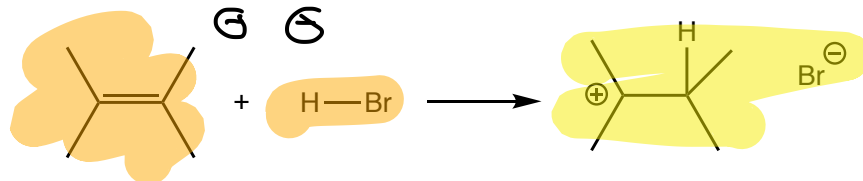


Reactant

Product

Transition State

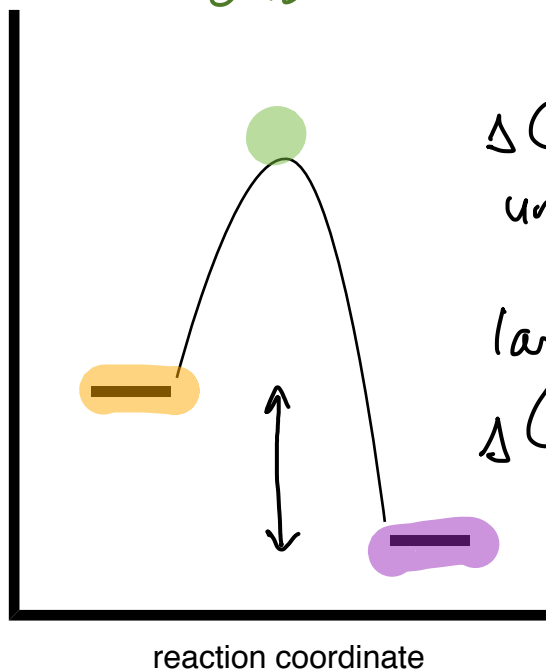
Intermediate



highest E point along the path between reactant and product.

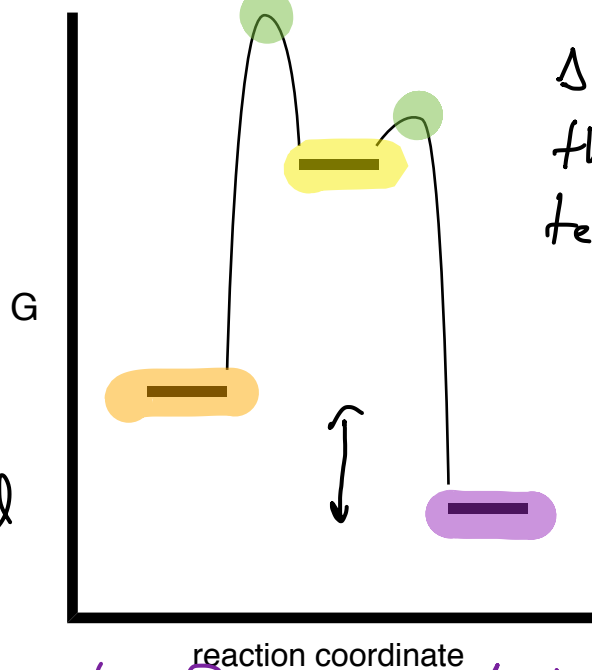
molecules + ions that are formed during a reaction and consumed by the end of the reaction

Energy  
 Gibbs Free energy  
 $G$



$\Delta G > 0$  small  $K$   
 unfavorable

large  $K$   
 $\Delta G = G_F - G_i$   
 energy is released  
 $\Delta G < 0$

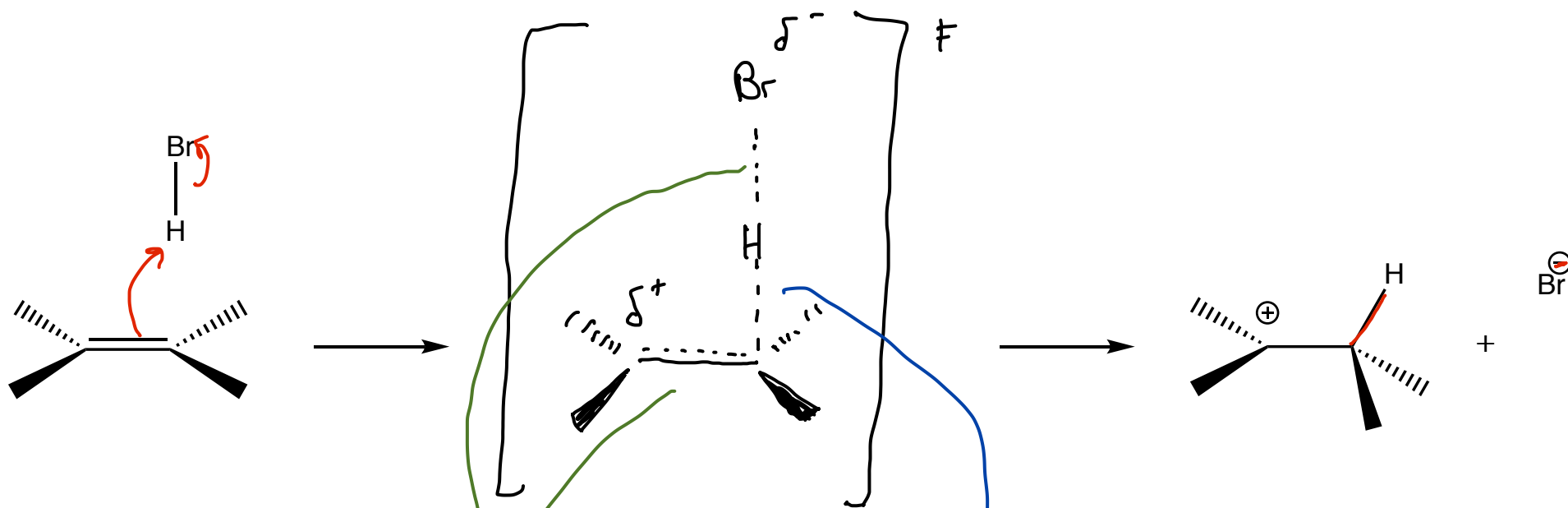


$\Delta G$  is a thermodynamic term

large  $K$   
 $\Delta G < 0$

↑ time... how far along the path from reactant to product

double dagger  $\rightarrow$  †



--- dotted line means a partial bond

highest E point between reactant and intermediate

represent bonds that are breaking

represent bonds that are forming

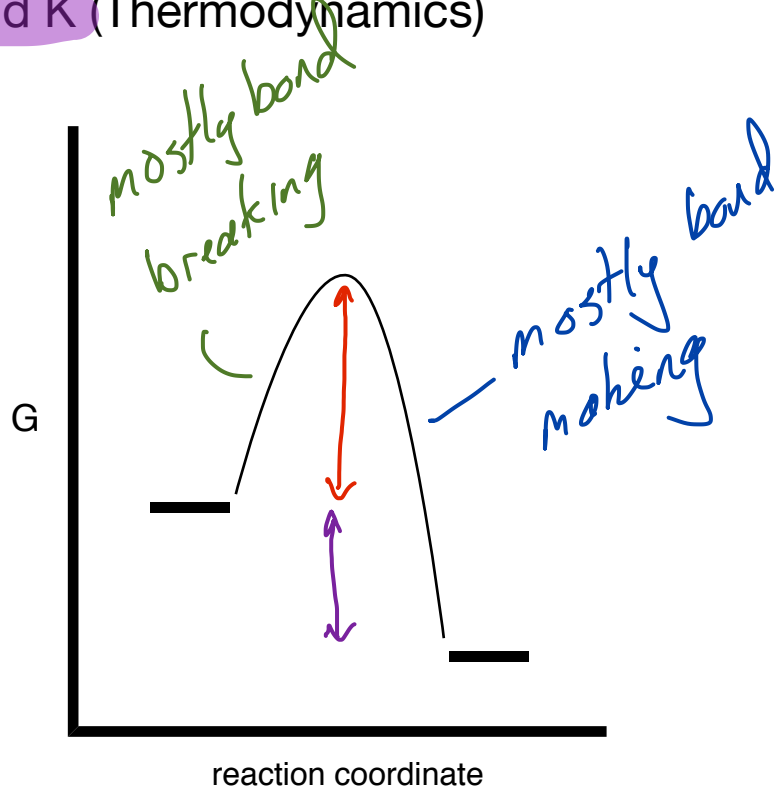


# Mechanism and Reaction Coordinate Diagrams

## Activation Energy (Kinetics), $\Delta G^\ddagger$

$$K = \frac{[products]}{[reactants]}$$

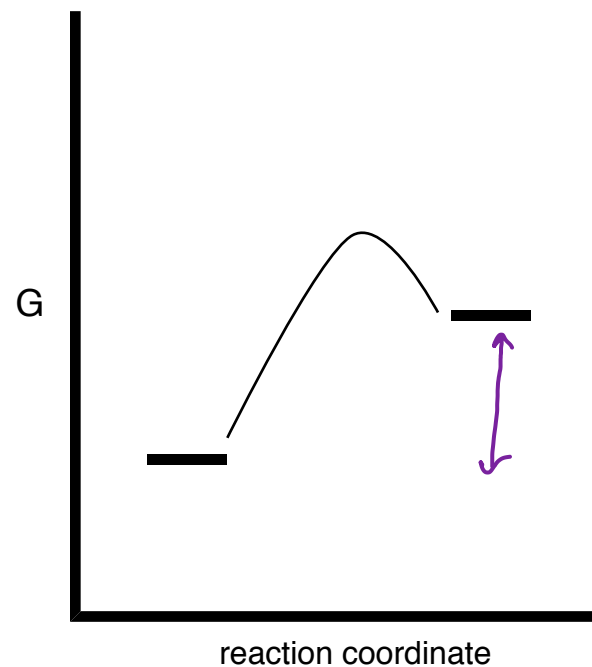
## $\Delta G$ and $K$ (Thermodynamics)



$$\Delta G < 0$$

$K$  Favorable

$$K > 1$$



$$\Delta G > 0$$

$K$  unfavorable

$$K < 1$$

