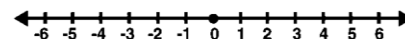


## Unit 2 – Thermodynamics

1. Thermodynamically favorable (spontaneous) reactions have a  $(-)\Delta G$ .
2. Reactions with  $(-)\Delta H$  and  $(+)\Delta S$  are ALWAYS thermodynamically favorable...  
“enthalpy driven & entropy driven”
3. Reactions that increase the # of moles of gas have a  $(+)\Delta S$ .
4. If  $\Delta G$  is  $(-)$ , then  $K_{eq} > 1$ .
5. If  $\Delta G$  is  $(-)$ , then the reaction is product favored.  
If  $\Delta G$  is  $(+)$ , then the reaction is reactant favored.
6.  $\Delta H$  and  $\Delta S$  are usually NOT given in the same units!! Be careful!  
When using  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ , make sure they match units.
7.  $\Delta G = 0$  at equilibrium.
8. When using  $\Delta G^\circ = -RT \ln K$ , the value for R is 8.314 J/mol K so the answer for  $\Delta G$  will be in the units of Joules.
9. Sometimes a reaction with a  $(-)\Delta G$  does not proceed at a measurable rate. They are said to be under “kinetic control.” High activation energy is a common reason for a process to be under kinetic control.
10. When using  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$  and  $\Delta S^\circ$  is a negative value, as T increases, we need to be careful of how we describe the mathematical impact on  $\Delta G^\circ$ . Subtracting negative numbers is hard to explain.  
Use safe phrases like:
  - As T increases, we are *subtracting a negative number that is larger in magnitude*, therefore...
    - $\Delta G^\circ$  will be a *less negative number*, therefore the reaction is less spontaneous.
    - $\Delta G^\circ$  will *shift in a more positive direction*, therefore the reaction is less spontaneous.
    - $\Delta G^\circ$  will *shift in a less negative direction*, and therefore the reaction is less spontaneous.

Remember...  $-3$  vs  $3 \rightarrow -3$  is more negative,  $3$  is less negative  
 $1$  vs  $3 \rightarrow 1$  is more negative,  $3$  is less negative



# Thou Shalt Not Forget Questions

Credit: Dan Reid

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## Unit 2 – Thermodynamics

1. Thermodynamically favorable (spontaneous) reactions have what algebraic sign for  $\Delta G$ ?
2. a) Reactions with what signs for  $\Delta H$  and  $\Delta S$  are ALWAYS thermodynamically favorable?  
b) Reactions with what signs for  $\Delta H$  and  $\Delta S$  are NEVER thermodynamically favorable?  
c) If a reaction is “enthalpy driven & entropy driven”, what are signs of  $\Delta H$  and  $\Delta S$ ?
3. If a reaction increases the # of moles of gas, then the sign for  $\Delta S$  is what?  
If a reaction decreases the # of moles of gas, then the sign for  $\Delta S$  is what?
4. If  $\Delta G$  is  $(-)$ , then  $K_{eq}$  is greater than or less than 1?  
If  $\Delta G$  is  $(+)$ , then  $K_{eq}$  is greater than or less than 1?
5. If  $\Delta G$  is  $(-)$ , then the reaction is \_\_\_\_\_ favored.  
If  $\Delta G$  is  $(+)$ , then the reaction is \_\_\_\_\_ favored.
6. What are the most common units for  $\Delta H$  and  $\Delta S$ ?
7. At equilibrium, what is the value of  $\Delta G$ ?
8. a) When using  $\Delta G^\circ = -RT \ln K$ , the value w/ units for  $R$  is \_\_\_\_\_.  
b) If you use the value of 8.314 for  $R$  in the equation  $\Delta G^\circ = -RT \ln K$ , then what are the units for  $\Delta G$ ?
9. Why might a reaction with a  $(-)\Delta G$  not proceed at a measurable rate?
10. If  $\Delta S^\circ$  is negative, as  $T$  increases, you are subtracting a \_\_\_\_\_ number,  
therefore  $\Delta G^\circ$  will \_\_\_\_\_,  
therefore the reaction will be \_\_\_\_\_ spontaneous,  
therefore the reaction will be more \_\_\_\_\_ favored,  
therefore  $K_{eq}$  will be \_\_\_\_\_.