AP Chemistry Daily Videos

9.3 Gibbs Free Energy and Thermodynamic Favorability

Video #1

1. What is Gibbs free energy?

2. What does ΔG° represent?

3. What values of ΔG° indicate a thermodynamically favorable process?

4. What is the equation used to calculate ΔG° for a reaction?

5. Pause the video @ 3:55 and try the problem on your own. Then evaluate your work and identify any errors you may have made.

$$CaSO_4 \cdot 2H_2O(s) \rightleftarrows CaSO_4(s) + 2H_2O(g)$$

The hydrate $CaSO_4 \cdot 2H_2O(s)$ can be heated to form the anhydrous salt $CaSO_4(s)$, as shown by the reaction represented above. Using the data in the table below, calculate the value of ΔG°, in kJ/mol_{rxn}, for the reaction at 298 K.

Substance	ΔG°_f at 298 K (kJ/mol)
$CaSO_4 \cdot 2H_2O(s)$	-1795.70
$CaSO_4(s)$	-1320.30
$H_2O(g)$	-228.59

6. What are the takeaways?

Video #2

1. What is the equation used to calculate the Gibbs free energy based on both entropy and enthalpy?

2. Complete the table with the temperature conditions necessary for a process to be thermodynamically favorable.

ΔH°	ΔS°	Symbols	$\Delta G^\circ < 0$, favored at:
< 0	> 0	< >	
> 0	< 0	> <	
> 0	> 0	> >	
< 0	< 0	< <	

3. Under which circumstances is a calculation for ΔG° necessary to determine favorability?

4. **Pause the video @ 4:55 and try the problem on your own. Then evaluate your work and identify any errors you may have made.**

$$3Ag(s) + 4HNO_3(aq) \rightarrow 3AgNO_3(aq) + NO(g) + 2H_2O(l)$$

A student investigates the reaction between Ag(*s*) and $HNO_3(aq)$ represented by the equation above.

a) Predict the sign of the entropy change, $\Delta S°$, for the reaction. Justify your answer.

b) Use the information in the table below to calculate the value of $\Delta H_{rxn}°$, the standard enthalpy change for the reaction, in kJ/mol_{rxn}.

c) Based on your answers to parts (a) and (b), is the reaction more likely to be thermodynamically favorable at 25°C or at 95°C? Justify your answer.

d) The student runs the reaction using a 3:4 mole ratio of Ag(*s*) to $HNO_3(aq)$. Suggest a method the student could use to isolate solid $AgNO_3$ from the other products of the reaction.

Substance	$HNO_3(aq)$	$AgNO_3(aq)$	$NO(g)$	$H_2O(l)$
Standard Heat of Formation, ΔH_f° (kJ/mol)	−207	−101	90.	−286

5. **What are the takeaways?**