

Study Guide – Entropy and Thermodynamics
Chemistry II - Chapter 27
2 points

DUE AT QUIZ

Name: _____

Date: _____

Topics to be covered on the May 4, 2010 quiz:

entropy (S , ΔS)

spontaneous

second law of thermodynamics

thermodynamics

first law of thermodynamics

third law of thermodynamics

enthalpy (H , ΔH)

Gibbs free energy (G , ΔG)

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

Practice problems:

- Which of the following processes are spontaneous?
 - Salt dissolves in water.
 - A clear solution becomes a uniform color after a few drops of dye are added.
 - Iron rusts.
 - You clean the kitchen.
 - A house is built.
 - A satellite is launched into orbit.
 - A satellite falls back to earth.
- Choose the chemical with the most entropy:
 - 1 mol H_2 at STP or 1 mol H_2 (at $100^\circ C$ at 0.5 atm)
 - 1 mol N_2 at STP or 1 mol N_2 (at 100 K and 2.0 atm)
 - 1 mole ice ($0^\circ C$) or 1 mole liquid water (at $20^\circ C$)
- Which of these involve an increase in the entropy of the system?
 - melting of a solid
 - sublimation
 - freezing
 - mixing
 - separation
 - boiling
- Predict the sign of $\Delta S_{\text{surroundings}}$ for the following processes:
 - $H_2O(l) \rightarrow H_2O(g)$
 - $CO_2(g) \rightarrow CO_2(s)$
- Given the values of ΔH and ΔS , predict which of the following will be spontaneous:
 - $\Delta H = 25 \text{ kJ}$, $\Delta S = 5.0 \text{ J/K}$, $T = 300 \text{ K}$
 - $\Delta H = 25 \text{ kJ}$, $\Delta S = 100. \text{ J/K}$, $T = 300 \text{ K}$
 - $\Delta H = -10. \text{ kJ}$, $\Delta S = 5.0 \text{ J/K}$, $T = 298 \text{ K}$
 - $\Delta H = -10. \text{ kJ}$, $\Delta S = -40. \text{ J/K}$, $T = 200 \text{ K}$
- At what temperatures will the following processes be spontaneous?
 - $\Delta H = -18 \text{ kJ}$ and $\Delta S = -60. \text{ J/K}$
 - $\Delta H = +18 \text{ kJ}$ and $\Delta S = +60. \text{ J/K}$
 - $\Delta H = +18 \text{ kJ}$ and $\Delta S = -60. \text{ J/K}$
 - $\Delta H = -18 \text{ kJ}$ and $\Delta S = +60. \text{ J/K}$
- For mercury, $\Delta H_{\text{vaporization}}$ is 58.51 kJ/mol , and the $\Delta S_{\text{vaporization}} = 92.92 \text{ J/K}\cdot\text{mol}$. What is the boiling point of mercury?
- For ammonia, the ΔH_{fusion} is 5.65 kJ/mol , and the ΔS_{fusion} is $28.9 \text{ J/K}\cdot\text{mol}$.
 - Will solid ammonia melt at $200. \text{ K}$?
 - What is the melting point of ammonia?

- 9) Predict the sign of ΔS° for each of the following changes:
- $\text{AgCl (s)} \longrightarrow \text{Ag}^+ \text{ (aq)} + \text{Cl}^- \text{ (aq)}$
 - $2 \text{H}_2 \text{ (g)} + \text{O}_2 \text{ (g)} \longrightarrow 2 \text{H}_2\text{O (l)}$
 - $\text{H}_2\text{O (l)} \longrightarrow \text{H}_2\text{O (g)}$
 - $\text{NaCl (s)} \longrightarrow \text{NaCl (l)}$
- 10) Predict which of the pair has a higher S° :
- graphite or a diamond
 - liquid ethyl alcohol or vapor ethyl alcohol
 - dry ice or carbon dioxide gas
 - N_2O at 0 K or N_2O at 10 K
- 11) Balance the equation, predict the sign of ΔS° , and then calculate ΔS° for the reaction:
- $\text{H}_2\text{S (g)} + \text{SO}_2 \text{ (g)} \longrightarrow \text{S}_{\text{rhombic}} \text{ (s)} + \text{H}_2\text{O (g)}$
 - $\text{SO}_3 \text{ (g)} \longrightarrow \text{SO}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$
 - $\text{Fe}_2\text{O}_3 \text{ (s)} + \text{H}_2 \text{ (g)} \longrightarrow \text{Fe (s)} + \text{H}_2\text{O (g)}$
 - combustion of methyl alcohol
- 12) For the reaction
- $$\text{C}_2\text{H}_2 \text{ (g)} + \text{F}_2 \text{ (g)} \longrightarrow \text{CF}_4 \text{ (g)} + \text{H}_2 \text{ (g)}$$
- balance the equation
 - The ΔS° is -358 J/K . Calculate the S° for CF_4 .
- 13) Consider the reaction
- $$2 \text{O (g)} \longrightarrow \text{O}_2 \text{ (g)}$$
- Predict the signs of ΔH and ΔS .
 - Would the reaction be more spontaneous at high or low temperatures?
- 14) Using your thermodynamics tables, calculate ΔH° , ΔS° , and ΔG° for each of the following reactions at 25°C : (Don't forget to balance!)
- combustion of methane
 - $\text{CO}_2 \text{ (g)} + \text{H}_2\text{O (l)} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_6 \text{ (s)} + \text{O}_2 \text{ (g)}$
 - $\text{P}_4\text{O}_{10} \text{ (s)} + \text{H}_2\text{O (l)} \longrightarrow \text{H}_3\text{PO}_4 \text{ (s)}$
 - $\text{HCl (g)} + \text{NH}_3 \text{ (g)} \longrightarrow \text{NH}_4\text{Cl (s)}$
- 15) For the reaction
- $$\text{SF}_4 \text{ (g)} + \text{F}_2 \text{ (g)} \longrightarrow \text{SF}_6 \text{ (g)}$$
- the value of ΔG° is -374 kJ . Use this and your thermodynamics tables to calculate the value of ΔG_f° for $\text{SF}_4 \text{ (g)}$.
- 16) Consider the reaction
- $$2 \text{NO (g)} \rightleftharpoons \text{N}_2\text{O}_4 \text{ (g)}$$
- For each of the following mixtures of reactants and products at 25°C , predict the direction in which the reaction will shift to reach equilibrium:
- $P_{\text{NO}_2} = P_{\text{N}_2\text{O}_4} = 1.0 \text{ atm}$
 - $P_{\text{NO}_2} = 0.21 \text{ atm}$, $P_{\text{N}_2\text{O}_4} = 0.50 \text{ atm}$
 - $P_{\text{NO}_2} = 0.29 \text{ atm}$, $P_{\text{N}_2\text{O}_4} = 1.6 \text{ atm}$
- 17) Consider the reaction
- $$\text{H}_2 \text{ (g)} + \text{Cl}_2 \text{ (g)} \longrightarrow 2 \text{HCl (g)}$$
- Calculate ΔH° , ΔS° , ΔG° , and K (equilibrium constant) at 298 K using the thermodynamics tables.
 - If the reactants and products are placed in a flask so that the pressure of each gas is 1 atm , in which direction will the equilibrium shift to reach equilibrium at 25°C ?