CHEM441-001/002
College of Charleston
Fall 1999
Exam V

1(20). A flask containing a 0.0500-mol sample of $N_2(g)$ at 1.00 bar at 25 °C is heated to 75 °C by placing it in a constant temperature bath at 75 °C. Assuming a negligible volume change, calculate ΔS(system), ΔS(surroundings), and ΔS(universe) for the gas. Over this temperature range the heat capacity of the gas can be considered to be constant and any vibrational contribution to the heat capacity is negligible.

2(30). Using the appropriate equations from statistical thermodynamics, calculate S^o_{298} for $O_2(g)$ given the following data for the ground state: g(electronic) = 3, $\tilde{\nu}$ = 1580. cm^{-1}, and I = 1.936×10^{-46} kg m^2.

Given S^o_{298} for $N_2(g)$ = 191.609 J K^{-1} mol^{-1} and S^o_{298} for $N_2O(g)$ = 219.957 J K^{-1} mol^{-1}, calculate $\Delta_f S^o_{298}$ for $N_2O(g)$. [Note: if you are not satisfied with your answer for S^o_{298} for $O_2(g)$ from above, use 200.000 J K^{-1} mol^{-1}.]

Given $\Delta_f H^o_{298}$ for $N_2O(g)$ = 82.048 kJ mol^{-1}, calculate $\Delta_f G^o_{298}$.

Is the enthalpy change favorable?
Is the entropy change favorable?
Is the formation reaction spontaneous?

3(15). Suppose S^o_{4000} for gaseous chromium was to be calculated from heat capacity and enthalpy of phase transformation data. Explain in detail (including a sketch of the proper graph) how you would do this calculation given the following information: C_p data from 15 K to 311.5 K for Cr(sI), ΔH for Cr(sI) to Cr(sII), C_p data from 311.5 K to 2130 K for Cr(sII), ΔH for fusion, C_p data from 2130 K to 2952 K for Cr(l), ΔH for vaporization, and C_p data from 2952 K to 4000 K for Cr(g).

4(10). Choose the process which involves the largest decrease in entropy:
a) $H_2O(l) \rightarrow H_2O(g)$
b) $H_2O(l) \rightarrow H_2O(s)$
c) $H_2O(s) \rightarrow H_2O(l)$
d) $H_2O(s) \rightarrow H_2O(g)$
e) $H_2O(g) \rightarrow H_2(g) + \frac{1}{2} O_2(g)$
Explain your choice.

5(25). For graphite the temperature dependence of the heat capacity is given by

$$C_p/(\text{J K}^{-1}\text{ mol}^{-1}) = 16.86 + 4.77 \times 10^{-3}\, T - 8.54 \times 10^{5}\, T^{-2}$$

Calculate ΔS for heating a molar sample from 25 °C to 1000 °C at constant pressure.

A student mistakenly calculated the value of ΔS using

$$\Delta S' = \frac{q}{(average\ T)} = \frac{\int C_p\ dT}{(average\ T)}$$

Calculate $\Delta S'$ and compare it to the correct value.