CH353 – Physical Chemistry I
Spring 2015, Unique 51170

Homework, Week 5

1. For each of the following processes determine whether ΔS_{sys} is greater than zero, less than zero, or equal to zero. Explain your reasoning.

a) An irreversible adiabatic process

b) A reversible adiabatic process

c) An irreversible isothermal expansion of an ideal gas

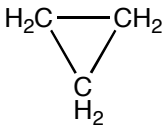
d) A reversible isothermal expansion of an ideal gas

2. Consider Figure 20.3 in McQuarrie & Simon. Determine q_{rev} and ΔS for a reversible cooling of 1.0 mole of an ideal gas at a constant volume V_1 from P_1, V_1, T_1 to P_2, V_1, T_4 followed by a reversible expansion at constant pressure P_2 from P_2, V_1, T_4 to P_2, V_2, T_1. Compare your result to q_{rev} and ΔS determined from pathway B + C in Figure 20.3 (assume both paths are reversible) and comment on any differences.

3. Vaporization at the normal boiling point of a substance (the boiling point at 1 atm, T_{vap}) is a reversible process. If ΔH_{vap} of water is 40.65 kJ mol^{-1}, determine ΔS_{vap} when 2.0 moles of water are vaporized at 100˚C. Comment on the sign of ΔS_{vap}.

4. For each of the following pairs of molecules, predict which has the greater molar entropy, assuming all are gaseous species under the same conditions. Briefly discuss your reasoning.

a. CO $\quad$ CO_2

b. $CH_3CH_2CH_3$ $\quad$ 

c. $CH_3CH_2CH_2CH_2CH_3$ $\quad$ $C(CH_3)_4$

5. Without referring to reference tables, arrange the following reactions according to increasing values of ΔS_{rxn}, and briefly discuss your reasoning.

a. $S(s) + O_2(g) \rightarrow SO_2(g)$
b. $H_2(g) + O_2(g) \rightarrow H_2O_2(l)$
c. $CO(g) + 3\ H_2(g) \rightarrow CH_4(g) + H_2O(l)$
d. $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$

6. Consider the mixing of two ideal gases, 1 and 2. Plot ΔS_{mix} against the mole fraction of species 1, n_1. Determine the value of n_1 that gives maximum ΔS_{mix} and provide a physical interpretation for this result.

7. A 10 g block of gold at 900 K is brought in contact with a 10 g block of silver at 300 K until thermal equilibrium is reached. If there is no heat exchange between the blocks and the surroundings, calculate the final temperature of the system, ΔS_{sys}, ΔS_{surr}, and ΔS_{Tot}. Assume C_p(Au) = 25.41 J K^{-1} mol^{-1} and C_p(Ag) = 25.38 J K^{-1} mol^{-1}, and remain constant over this temperature range.