

CH353 – Physical Chemistry I
Spring 2012, Unique 52135

Homework, Week 5

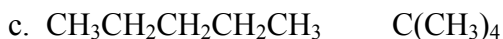
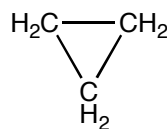
1. For each of the following processes determine whether ΔS_{sys} is greater than zero, less than zero, or equal to zero. Explain your reasoning.

- 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 $40.65 \text{ kJ mol}^{-1}$, 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.



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

- a. $\text{S(s)} + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$
- b. $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}_2(\text{l})$
- c. $\text{CO}(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{l})$
- d. $\text{C(s)} + \text{H}_2\text{O}(\text{g}) \rightarrow \text{CO}(\text{g}) + \text{H}_2(\text{g})$

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 $C_p(\text{Au}) = 25.41 \text{ J K}^{-1} \text{ mol}^{-1}$ and $C_p(\text{Ag}) = 25.38 \text{ J K}^{-1} \text{ mol}^{-1}$, and remain constant over this temperature range.