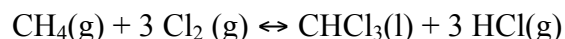


CH302H – Principles of Chemistry II: Honors
Fall 2014, Unique 51880

Homework, Week 6

1. Chloroform can be synthesized from natural gas and elemental chlorine according to the following reaction:

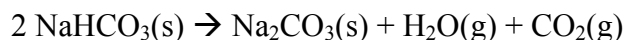


- a) Determine $\Delta G^\circ_{\text{rxn}}$ for this system.
- b) Assuming ΔH°_f and S°_m remain constant, will this reaction proceed spontaneously at 500 K?

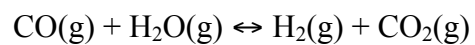
The following data could be useful.

	<u>CH₄(g)</u>	<u>Cl₂(g)</u>	<u>CHCl₃(l)</u>	<u>HCl(g)</u>
ΔH°_f (kJ/mol)	-74.81	0	-135.44	-92.31
S°_m (J/K mol)	186.26	223.07	216.40	186.91
ΔG°_f (kJ/mol)	-50.72	0	-73.66	-95.30
ρ (g/cm ³)	0.720	0.940	1.499	1.187

2. The protein lysozyme unfolds at a transition temperature of 75.5 °C with $\Delta H_{\text{unfold}} = 509 \text{ kJ mol}^{-1}$. Calculate the entropy of unfolding of lysozyme at 25°C, given that the difference in the constant-pressure heat capacities upon unfolding is $6.28 \text{ kJ K}^{-1} \text{ mol}^{-1}$ and is assumed to be independent of temperature.
3. The molar enthalpy of vaporization of chloroform (CHCl₃) at its normal boiling point, 80.1°C, is 30.7 kJ mol^{-1} . Assuming that ΔH_{vap} and ΔS_{vap} remain constant, determine ΔG_{vap} at 75°C, 80.1°C, and 85°C.
4. Most of the portable red fire extinguishers that you see in public buildings or can purchase for your home (the so-called “ABC dry chemical” extinguishers) contain powdered sodium bicarbonate that decomposes when exposed to high temperature (for example from a fire) into sodium carbonate, water, and carbon dioxide:



- a) Determine the equilibrium constant of the reaction at 150°C.
- b) At equilibrium, if the partial pressure of CO₂(g) is 0.80 atm, what is the partial pressure of H₂O(g)?
5. The water-gas shift reaction is an important industrial source of pure H₂(g) for ammonia synthesis:



What would happen to the equilibrium concentration of each species if you increase the total pressure of the system by a factor of 100?

6. Under certain conditions, water vapor dissociates into $\text{H}_2\text{(g)}$ and $\text{O}_2\text{(g)}$. At 2100 K and 1 bar, the equilibrium constant for the dissociation reaction is twice as large as at 2000 K and 1 bar. Determine the enthalpy of the dissociation reaction, assuming it is constant over this temperature range.