CH353 – Physical Chemistry I
Spring 2015, Unique 51170

Homework, Week 6

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

$$CH_4(g) + 3\ Cl_2\ (g) \leftrightarrow CHCl_3(l) + 3\ HCl(g)$$

a) Determine the Gibbs energy, ΔG°_{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.

	$CH_4(g)$	$Cl_2(g)$	$CHCl_3(l)$	$HCl(g)$
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 ΔH_{unfold} = 509 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 kJ mol^{-1} and is assumed to be independent of temperature.

3. Provide a physical interpretation for the Helmholtz energy, ΔA, of any reversible transformation.

4. a) What is the volume dependence of the enthalpy of an ideal gas held at constant temperature?

b) A gas obeys the following equation of state:

$P(V - b) = nRT$ where $b > 0$ always.

What is the volume dependence of the enthalpy of this gas at constant temperature? Account for any differences from your solution to part a.

5. a) What is the change in the Gibbs free energy of one mole of an ideal gas at 300 K when the pressure is increased isothermally and reversibly from 1 bar to 10 bar?

b) What is the change in the Gibbs free energy of 18 g of a liquid with a density of 1.0 x 10^3 kg m^{-3} held at 300 K when the pressure is increased isothermally and reversibly from 1 bar to 10 bar?

c) Explain the reason for the difference in your answers for parts a and b.