UNIVERSITY OF MANITOBA
DEPARTMENT OF CHEMISTRY

Chemistry 2290, Winter 2012, G. Schreckenbach

PROBLEM SET 5, March 23, 2012

Due date: The solved problem set is due on Monday, April 2, 2012, at the time of the lecture.
Questions to be marked: Five of the six questions will be marked.

1. Consider a concentration cell consisting of two hydrogen electrodes connected by a salt bridge. Let the concentrations of H^+ (aq) be $m_1 = 0.20\ mol\ L^{-1}$ and $m_1 = 3.00\ mol\ L^{-1}$, respectively. For this cell, calculate the cell potential at 298.15K.

2. Given the following half reactions and E^0 values:

$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $\quad E^0 = +0.771$ V

$Fe^{2+}(aq) + e^- \rightarrow Fe(s)$ $\quad E^0 = -0.447$ V

Calculate the E^0 for the half-cell reaction $Fe^{3+}(aq) + e^- \rightarrow Fe(s)$

3. For the Daniell cell *(see lecture)* $E^0 = 1.10$ V. Calculate the equilibrium constant K for the cell reaction $Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Zn^{2+}\ (aq) + Cu\ (s)$.

4. The standard emf (cell potential) of the cell

$Pt(s) \mid H_2(g) \mid HBr(aq) \mid AgBr(s) \mid Ag(s)$

was measured over a range of temperatures, and the data were fitted to the following polynomial:

$$E^0 / V = 0.07131 - 4.99 \times 10^{-4}\ (T/K - 298) - 3.45 \times 10^{-6}\ (T/K - 298)^2$$

(a) Using this data, determine the standard reaction Gibbs energy, enthalpy and entropy at 298 K.
(b) Also determine the Gibbs energy of reaction at 323 K.

5. In an osmotic pressure experiment to determine the molar mass of a macromolecule the following osmotic pressure was found at 25.0°C:

$\pi = 2.17$ atm for a volume concentration (m/V) of the solute of 290.0g/L.

What is the molar mass of the solute?

This question is similar to question LM51 out of the "Laidler" questions posted.

6. Pure liquid water has a boiling point of 100.0°C at atmospheric pressure. In order to raise the boiling point of the liquid, we could either (a) raise the external pressure (such as by using a pressure cooker) or (b) add an involatile solute such as NaCl.
For a boiling point of 102.0°C,
(a) what external pressure would be required ($\Delta H_{vap}(H_2O) = 40.6$ kJ mol^{-1}; assumed constant.), or
(b) what amount (in terms of *mass*) of NaCl would have to be added to 1.00 mol of pure water?