

Chemistry 2290, Winter 2011, G. Schreckenbach

Practice problems –9–

Electrolyte Solution

Engel and Reid, 2nd ed.:

Questions on concepts: Q10.2, Q10.4, Q10.5, Q10.6, Q10.7, Q10.13

Problems: P10.1, P10.2, P10.15, P10.28

Electrochemistry

Engel and Reid, 2nd ed.:

Questions on concepts: Q11.4, Q11.6 (*both of these are probably a bit harder*),

Problems: P11.1, P11.2, P11.3, P11.4, P11.6, P11.7, P11.8, P11.9, P11.10, P11.12, P11.14, P11.15, P11.16, P11.19, P11.20, P11.23, P11.24, P11.25, P11.29, P11.30

This is again only a selection. In fact, almost all of the problems of this section are useful and appropriate for us.

Electrochemistry

Practice problems from Laidler/ Meiser

(Problems adapted from Laidler, Meiser, Sanctuary, Physical Chemistry, 4th ed., Houghton Mifflin)

(For some of these questions, you may have to use a table of Standard Reduction Potentials.)

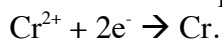
LM53. At 25°C and pH 7, a solution containing compound A and its reduced form AH₂ has a standard electrode (reduction) potential of –0.60V. Likewise, a solution containing compound B and BH₂ has a standard electrode (reduction) potential of –0.16V. If a cell were constructed with these systems as half-cells,

(a) Would AH₂ be oxidized by B or BH₂ oxidized by A under standard conditions?

(b) What would be the cell voltage (emf)?

(c) What would be the effect of pH on the reaction quotient – and thus on the E⁰?

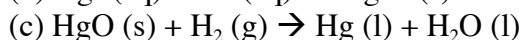
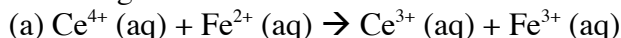
LM54. Calculate the standard potential for the half reaction (298.15K)



Use the following half reactions and E⁰ values:

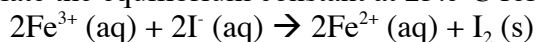


LM55. Using appropriate half reactions, design electrochemical cells in which each of the following reactions occurs:



In each case, write the representation of the cell and the reactions at the two electrodes. Also calculate the cell potential.

LM56. Calculate the equilibrium constant at 25.0°C for the reaction

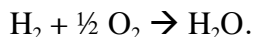


using appropriate standard potentials.

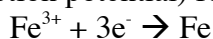
LM57. From a table of standard potentials, calculate the equilibrium constant at 25.0°C for the reaction



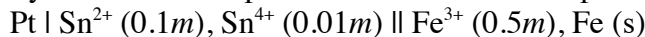
LM58. Using appropriate standard potentials, calculate the standard Gibbs energy change $\Delta_r G^\circ$ for the reaction



LM59. (a) Using appropriate standard potentials, calculate the standard electrode potential (reduction potential) for the half reaction



(b) Use your result from part a to calculate the cell potential (emf) at 25.0°C of the cell:



(N.B. recall, the symbol *m* stands for molality, mol/kg; the junction between the two cells should be a salt bridge.)

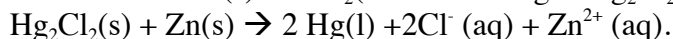
Electrochemical Cells

Practice problems from Atkins/ de Paula

(Problems adapted from Atkins, de Paula, Physical Chemistry, 8th ed., W. H. Freeman and co.)

(For some of these questions, you may have to use a table of Standard Reduction Potentials.)

A08. Consider the cell $\text{Zn}(s) \mid \text{ZnCl}_2(0.0050 \text{ mol kg}^{-1}) \mid \text{Hg}_2\text{Cl}_2(s) \mid \text{Hg}(l)$, for which the cell reaction is



Given that $E^\circ(\text{Zn}^{2+}, \text{Zn}) = -0.7628 \text{ V}$, $E^\circ(\text{Hg}_2\text{Cl}_2, \text{Hg}) = +0.2676 \text{ V}$, and the potential difference (the “emf”) is +1.2272 V,

(a) write the Nernst equation for this cell;

(b) determine the standard cell potential;

(c) determine $\Delta_r G$ and $\Delta_r G^\circ$ as well as the equilibrium constant *K* for this cell.

(Note: parts of this problem are a bit involved. Atkins, 8th ed., P7.16 a, b, c)

A09. Write the cell reaction and electrode half reactions and calculate the standard cell potential for each of these cells: (Atkins, 8th ed., E7.14(a) and E7.14(b))

(a) $\text{Zn} \mid \text{ZnSO}_4(\text{aq}) \parallel \text{Ag}(\text{NO}_3)(\text{aq}) \mid \text{Ag}$

(b) $\text{Cd} \mid \text{CdCl}_2(\text{aq}) \parallel \text{HNO}_3(\text{aq}) \mid \text{H}_2(\text{g}) \mid \text{Pt}$

(c) $\text{Pt} \mid \text{K}_3[\text{Fe}(\text{CN})_6](\text{aq}), \text{K}_4[\text{Fe}(\text{CN})_6](\text{aq}) \parallel \text{CrCl}_3(\text{aq}) \mid \text{Cr}$

(d) $\text{Pt} \mid \text{Cl}_2(\text{g}) \mid \text{HCl}(\text{aq}) \parallel \text{K}_2\text{CrO}_4(\text{aq}) \mid \text{Ag}_2\text{CrO}_4(\text{aq}) \mid \text{Ag}$

(e) $\text{Pt} \mid \text{Fe}^{3+}(\text{aq}), \text{Fe}^{2+}(\text{aq}) \parallel \text{Sn}^{4+}(\text{aq}), \text{Sn}^{2+}(\text{aq}) \mid \text{Pt}$

(f) $\text{Cu} \mid \text{Cu}^{2+}(\text{aq}) \parallel \text{Mn}^{2+}(\text{aq}), \text{H}^+(\text{aq}) \mid \text{Pt}$

A10. Calculate the equilibrium constants for the following reactions at 25°C from standard potential data: (Atkins, 8th ed., E7.17(a))

