Chemistry 2290, Winter 2011, G. Schreckenbach
Practice problems –9–

Electrolyte Solution

Engel and Reid, 2^{nd} 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, 2^{nd} 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 selction. 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, 4^{th} ed., Houghton Mifflin)

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

LM53. At 25ºC and pH 7, a solution containing compound A and its reduced form AH_2 has a standard electrode (reduction) potential of –0.60V. Likewise, a solution containing compound B and BH_2 has a standard electrode (reduction) potential of –0.16V. If a cell were constructed with these systems as half-cells,

(a) Would AH_2 be oxidized by B or BH_2 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 E^0?

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

$$Cr^{2+} + 2e^- \rightarrow Cr.$$

Use the following half reactions and E^0 values:

$$Cr^{3+} + 3e^- \rightarrow Cr \qquad E^0 = -0.74V$$
$$Cr^{3+} + e^- \rightarrow Cr^{2+} \qquad E^0 = -0.41V$$

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

(a) Ce^{4+} (aq) + Fe^{2+} (aq) $\rightarrow$ Ce^{3+} (aq) + Fe^{3+} (aq)

(b) Ag^+ (aq) + Cl^- (aq) $\rightarrow$ AgCl (s)

(c) HgO (s) + H_2 (g) $\rightarrow$ Hg (l) + H_2O (l)

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 25.0ºC for the reaction

$$2Fe^{3+} (aq) + 2I^- (aq) \rightarrow 2Fe^{2+} (aq) + I_2 (s)$$

using appropriate standard potentials.

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

$$Sn + Fe^{2+} \rightarrow Sn^{2+} + Fe.$$

LM58. Using appropriate standard potentials, calculate the standard Gibbs energy change Δ_rG^0 for the reaction

$H_2 + ½ O_2 \rightarrow H_2O$.

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

$Fe^{3+} + 3e^- \rightarrow Fe$

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

Pt | Sn^{2+} (0.1*m*), Sn^{4+} (0.01*m*) || Fe^{3+} (0.5*m*), Fe (s)

(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 Zn(s) | $ZnCl_2$(0.0050 mol kg^{-1} | Hg_2Cl_2(s) Hg(l), for which the cell reaction is

$Hg_2Cl_2(s) + Zn(s) \rightarrow 2\,Hg(l) + 2Cl^-\,(aq) + Zn^{2+}\,(aq)$.

Given that E^0 (Zn^{2+}, Zn) = -0.7628 V, E^0 (Hg_2Cl_2, Hg) = +0.2676 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 Δ_rG and Δ_rG^0 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) Zn | $ZnSO_4$ (aq) || $Ag(NO_3)$ (aq) | Ag
(b) Cd | $CdCl_2$ (aq) || HNO_3 (aq) | H_2 (g) | Pt
(c) Pt | $K_3[Fe(CN)_6]$ (aq), $K_4[Fe(CN)_6]$ (aq) || $CrCl_3$ (aq) | Cr
(d) Pt | Cl_2 (g) | HCl (aq) || K_2CrO_4 (aq) | Ag_2CrO_4 (aq) | Ag
(e) Pt | Fe^{3+} (aq), Fe^{2+} (aq) || Sn^{4+} (aq), Sn^{2+} (aq) | Pt
(f) Cu | Cu^{2+} (aq) || Mn^{2+} (aq), H^+ (aq) | Pt

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

(a) $Sn\,(s) + Sn^{4+}\,(aq) \longleftrightarrow 2Sn^{2+}\,(aq)$
(b) $Sn\,(s) + 2\,AgCl\,(s) \longleftrightarrow SnCl_2\,(aq) + 2Ag\,(s)$