

Problem Set #9 – Chemistry 102 – The last one for 2008

Due Wednesday April 23<sup>rd</sup> at the beginning of lecture

Problems from Whitten: Ch. 4; #'s **41, 69** & Ch. 11, # **57**, Ch. 21 #'s 51, 67, 103

1. (Held over by popular demand!)

FeS is a slightly soluble salt with a  $K_{sp}$  of  $4.8 \times 10^{-15}$ .

a. Assuming that sulfide is not reactive with hydrogen ions, calculate the saturating (equilibrium) concentration of  $Fe^{2+}$  in water exposed to an excess of FeS.

In reality, sulfide is a moderately strong base, with a  $pK_{b1}$  of 2, and furthermore its conjugate acid,  $HS^-$ , can also accept a proton with a  $pK_{b2}$  of 7. Thus, when FeS dissolves, some of the  $S^{2-}$  disappears due to reaction with hydrogen ions in solution.

b. At pH 11, 11% of total sulfide in solution will remain unreacted with protons – that is as  $S^{2-}$ . What would be the saturating concentration of  $Fe^{2+}$  in a solution at pH 11 exposed to FeS.

c. At pH 3, most sulfide ( $S^{2-}$ ) reacts with protons to create  $H_2S$  and  $HS^-$ . Only 1 part in  $10^{13}$  remains as  $S^{2-}$  in solution (the rest has largely been converted to  $HS^-$  and  $H_2S$ ). What concentration of  $Fe^{2+}$  will exist in a solution at pH 3.0 that has come to equilibrium with solid FeS?

2. For each of the following:

(i) Identify the oxidation state of each atom (except oxygen and hydrogen).

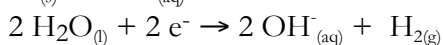
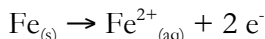
(ii) Balance the reactions using the half-reaction method.

a.  $I_{2(aq)} + SO_3^{2-(aq)} \rightarrow I_{(aq)}^- + SO_4^{2-(aq)}$  in basic solution

b.  $Cr_2O_7^{2-(aq)} + C_2H_6O_{(aq)} \rightarrow Cr^{3+(aq)} + C_2H_4O_{2(aq)}$  in acidic solution

c.  $NO_3^-(aq) + C_6H_{12}O_{6(aq)} \rightarrow N_2O_{(g)} + CO_{2(g)}$  in acidic solution

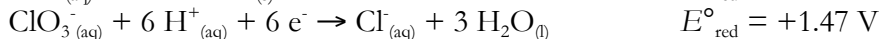
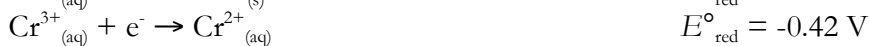
3. Two half-reactions are proposed for the corrosion of iron in the absence of oxygen:



a. Diagram an electrochemical cell that uses these two half-reactions.

b. Calculate the cell potential if this pair of half-reactions are in the standard state.

4. (This material will be covered in Friday's lecture) You are given two solutions of ionic compounds, 1.0 M  $CrI_{2(aq)}$  and 1.0 M  $Cu(ClO_3)_2$ . Given the following standard reduction potentials:



a. Prepare an "electron ladder" that contains the five reduction potentials given above.

b. Predict all spontaneous reactions that could take place when the two solutions are mixed (write out the balanced reactions and give  $E^\circ_{rxn}$ ).

c. Calculate  $\Delta G^\circ$  for each of the spontaneous reactions.