CHE 514, Descriptive Inorganic Chemistry
Spring, 2005
Readings and Problem Set 2

Acid-Base Chemistry, Oxidation and Reduction
Reading: MacKay chapters 6 and 8.
Useful reference: Douglas et al. 3rd Edition Chapter 7 (Acid-Base Chemistry in the CP library)

1. (10) Write an equilibrium equation for the autoionization of pure CF_3SO_3H. Find an equilibrium constant and calculate the concentrations of the lyate and lyonium ions at room temperature.
2. (10) Write an equation that shows the acid-base behavior of HF in CF_3SO_3H. Repeat for SbF_5. in CF_3SO_3H.
3. (5) Compare and explain the relative acidity of $HClO_4$ and $HClO_3$.
4. (5) Is an aqueous solution of $Fe(NO_3)_3$ slightly acidic, slightly basic or neutral? Why?
5. (9) What are the oxides (anhydrides) corresponding to (a) $Cr(OH)_3$; (b) H_3PO_3; (c)HNO_3?
6. (5) Describe the reaction of CO_2 with MgO according to the Lux-Flood acid-base model.
7. (10) Write an equilibrium equation for the autoionization of IF_5. Identify the lyate and lyonium ions.
8. (5) Should this equilibrium be favorable or unfavorable?
MeHgI(aq) + HCl(aq) <-> MeHgCl(aq) + HI(aq)
9. (10) Write a half-reaction for the oxidation of hydrazine to dinitrogen in water.
10. (10) Balance this redox reaction in basic solution.
$V(s) + ClO_3^-(aq) \rightarrow HV_2O_7^{3-}(aq) + Cl^-(aq)$
11. (15) Draw electron-dot diagrams for nitrous acid (HONO), the hydrogen hyponitrite ion $[HONNO]^-$ and the trioxodinitrate(II) ion $[ONNO_2]^{2-}$. Indicate the oxidation state and formal charge of each atom.
12. (15) Use Fig. 8.16 of MacKay to answer these questions.
(a) Why does the free energy line for carbon have a bend in it?
(b) In what temperature range can carbon be used to reduce NiO to Ni?
(c) In what temperature range can Mg be used to reduce Cr_2O_3 to Cr?
(d) Is carbon a suitable reductant for converting Al_2O_3 to Al?
(e) Aside from temperature requirements, can you think of any potential complication in using carbon to reduce TiO_2 to Ti?
13. (a) (10) Construct a Frost diagram for titanium in acidic, aqueous solution from the data on the Latimer diagram.
    (b) (2) Which is the most stable form of titanium under these conditions?
    (c) (2) Does any species on the diagram disproportionate under these conditions? If so, what are the products of its disproportionation?
    (d) (3) Calculate the standard reduction potential for the half-reaction:

$$Ti^{3+}(aq) + 3\ e^- \rightarrow Ti(s)$$