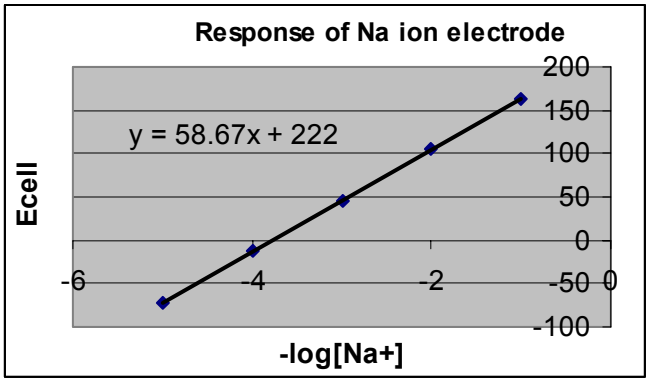
Exam 2
Chem 311
Fall 2003

This is an open book exam EXCEPT for Chapter 18-20

1) A 100.0 ml solution of 0.0100 M $K_2Cr_2O_7$ M and 0.00100 M $FeCl_3$ in 1.0 M HNO_3 is mixed with 50.00 ml of a solution containing 1.00 mM $Cr(NO_3)_3$ and 0.100 M $Fe(NO_3)_2$ in 1.0 M HNO_3. (20 pts)
   - Write a complete redox reaction describing this mixture. Answer the following questions according to the way in which you have chosen to write the reaction!!!!
   - Calculate the $\Delta G°$, E, and K for the reaction.
   - Calculate the concentration of Cr^{3+} at equilibrium.

2) A sodium ion electrode is used to measure the sodium concentration of seawater. The measurement of a series of standard Na^+ solutions (each having a pH = 7 and only trace levels of K^+) produced the following data. (18 pts)

[Na+] (M)	(log[Na+])	Ecell (mV)
0.1000	-1	163.33
0.01000	-2	104.66
0.001000	-3	45.99
0.0001000	-4	-12.68
0.00001000	-5	-71.35



A plot of the log[Na^+] vs Ecell, gives a slope of 58.67 mV and an intercept of 222 mV. A sample of seawater is diluted by a factor of 10 with ultrapure de-ionized water and measured with the sodium ion electrode, giving a voltage of 34.3 mV.

Part A) Calculate the [Na^+] concentration of the seawater assuming that the response to the K^+ and H^+ in the seawater is negligible.

Part B) The pH of the diluted seawater was found to be 5.5 as measured with a pH meter. Given that the selectivity factor of the sodium ion electrode is $k_{Na+/H+} = 36$, calculate the percent error you would expect in the calculated [Na^+] from Part A.

(16 pts)

3) Calculate the $[Cl^-]$ in the silver/silver chloride reference electrode.

Calculate the $[Cl^-]$ in the calomel reference electrode.

Theoretically, would the response of a pH meter change (in terms of the mV), if the filling solutions of the silver/silver chloride reference electrodes were replaced with 0.1 M HCl (no KCl/AgCl). Justify your answer!!!! HINT: the other junction potential

4) A solution containing $NaIO_3$ and $NaIO_4$ was analyzed by buffering a 25.00 ml sample at a slightly basic pH and adding excess KI. At this pH IO_4^- is reduced to IO_3^-, liberating and equivalent amount of I_2, which was subsequently titrated to an endpoint of 15.52 ml of 0.08029 M $Na_2S_2O_3$.

In a second experiment, a 10 ml aliquot of the sample was made strongly acidic after the addition of KI; 36.73 ml of the $Na_2S_2O_3$ was needed to titrate the I_2 liberated by both the IO_4^- and the IO_3^-. Calculate the concentration of $NaIO_3$ and $NaIO_4$ in the solution in terms of mg/ml. (20 pts)

$I_{2(aq)} + 2e^- \leftrightarrow 2I^-$ $\quad E^0 = 0.620$ V

$S_4O_6^{2-} + 2e^- \leftrightarrow 2S_2O_3^{2-}$ $\quad E^0 = 0.08$ V

At neutral –slightly basic conditions:

$IO_4^- + 2H^+ + 2e^- \leftrightarrow IO_3^- + H_2O$ $\quad E^0 = 1.589$ V

Acidic conditions

$IO_4^- + 8H^+ + 7e^- \leftrightarrow 1/2I_2 + 4H_2O$ $\quad E^0 = 1.3$ V

$IO_3^- + 6H^+ + 5e^- \leftrightarrow 1/2I_2 + 3H_2O$ $\quad E^0 = 1.20$ V

5) In general there are two types of UV-vis instruments; scanning instruments and diode array instruments. Discuss the advantages and disadvantages of the scanning instrument compared to the diode array instrument. You may want to sketch diagrams of the instruments to guide your answer.(10)

6) Arrange the following types of radiation in terms of increasing wavelength (16 pts)

Radio waves, X-rays, IR, UV, gamma rays, visible, microwave

Which type of radiation matches best with each of the following terms?

a) Outer electrons energy levels

b) Rotational motion of molecules

c) Nuclear spin states

d) Vibrational motion of molecules

e) Inner shell electron energy levels

f) d-orbital splitting in transition metals

g) functional group analysis

h) elemental composition

i) structural analysis of molecules

j) NMR