**A. Problems** [Note: $\mathcal{E}^o$ denotes standard emf.]

**[1]** For the cell: Cu | $CuCl_2$ (m) | AgCl | Ag
$\mathcal{E}_{298K}$ is 0.193 V and -0.074 V for m = $10^{-4}$ mol/Kg and m = 0.2 mol/Kg, respectively.

Write the electrode and net cell reactions, and calculate the mean activity coefficient for 0.2 mol/Kg $CuCl_2$. [Hint: Note that when m is very small, we can assume unity mean activity coefficient.]

**[2]** Given that $\mathcal{E}^o_{298K}$ is -0.627 V for the cell:

Ag | $Ag_2SO_4$ (s) || $H_2SO_4$ (m) | $H_2$ (1 bar) | Pt

**a.** Write down the cell reaction, and each electrode reaction.
**b.** Calculate $\mathcal{E}_{298K}$ if m = 0.1 mol/Kg (assume the activiity coefficients are unity and $\mathcal{E}^o_{298K}$ = -0.627 V).
**c.** Repeat the calculation in part b, but take the mean activity coefficient of $H_2SO_4$ (0.1 mol/Kg) to be 0.27.

**[3]** Given the following information:

$Cr + SO_4^{2-} = CrSO_4(s) + 2e^-$ $\quad\quad$ $\mathcal{E}^o_{298K}$ = 0.4 V
$Cr = Cr_3^+ + 3e^-$ $\quad\quad$ $\mathcal{E}^o_{298K}$ = 0.5 V
K for $CrSO_4$ is $10^{-6}$ at 25°C.

**a.** Write the cell reaction for the cell:

Cr | $CrSO_4$ (s) || $H_2SO_4$ (0.001 mol/Kg) | $H_2$ (1 bar) | Pt

**b.** Calculate the emf for this cell at 25°C (assume the activity coefficients are unity).
**c.** Calculate $\mathcal{E}^o$ for this cell at 50°C if $\Delta H^o$ is -10kJ.
[Hint: Think of a simple way to estimate $\partial\mathcal{E}^o/\partial T$.]
**d.** Calculate the emf for this cell at 25°C, using activity coefficients from the Debye-Hückel limiting law. [Use the B constant given in the lecture notes.]

**[4]** Using the following data for this electrochemical cell:

Ag | AgBr (s) || HBr (0.1 mol/Kg) | $H_2$ (0.01 bar) | Pt
$\mathcal{E}_{298K}$ = -0.165 V; $\Delta H^o$ = -50 kJ
K for AgBr is $10^{-12}$ and $\mathcal{E}^o_{298K}$ for $Ag/Ag^+$ is -0.8 V.

**a.** Write down the cell reaction.
**b.** Calculate $\mathcal{E}^o_{298K}$ for the cell.
**c.** Calculate $q_{rev}$ [the heat absorbed per Faraday when the cell operates reversibly] at 298 K. Calculate $\Delta S$.
**d.** Calculate $\gamma_\pm$ for 0.1 mol/Kg HBr.

**[5]** For the cell: Ag | $Ag_2SO_4$ (s) || $H_2SO_4$ (0.1 mol/Kg) | $H_2$ (1 bar) | Pt,
$\mathcal{E}$ and $\mathcal{E}^o$ are -0.7 V and -0.63 V at 25°C, respectively.

Calculate the difference ($\mathcal{E}$ - $\mathcal{E}^o$) at 35°C.

PLEASE NOTE: You are allowed to have a calculator and ONE 8.5"x11" single-sided page of "cheat-sheet" for the Final Exam.