FCH 361 - Physical Chemistry II

Exam I
February 1x, 2001

PUT YOUR **NAME** ON YOUR EXAM BOOK.
Put all your answers in the exam book.
TO GET ANY CREDIT, YOU MUST SHOW YOUR WORK!!

Possibly Useful Data

R = 8.314 J/(mole K)	$k=R/N_A = 1.3806 \times 10^{-23}$ J/K
F=96,485 Coulombs/mole	1 Å = 10^{-10} meters

I (25 pts) Consider a cell undergoing the reaction below at 298 K

$$2\ Na_{(s)} + Cd^{2+}_{(aq)} \Leftrightarrow 2\ Na^{+}_{(aq)} + Cd_{(s)}$$

When $[Na^+] = 0.0005$ molal ($\gamma_\pm = 0.974$) and $[Cd^{2+}] = 0.2$ molal ($\gamma_\pm = 0.102$), then $E_{cell} = +2.45$ V.

What is E° for the cell?

II (20 pts) For $In_2(SO_4)_3$, what is the error in the extended Debye-Huckel law at **0.05** molal ($\gamma_\pm$ from experiment = 0.035), assuming the value of B in the extended Debye-Huckel law is B = 0.4 ?

What is the error in the Debye-Huckel limiting law at **0.01** molal, assuming the extended Debye-Huckel law works at 0.01 molal?

III (25 pts) The question and the data below all refer to 298 K.

The radius of a CH_3OH molecule = 1.8 Å.

For a CH_3OH molecule in water, the time interval between jumps is 4.1×10^{-11} seconds.

The diffusion coefficient of an H_2O molecule in water is 2.26×10^{-9} m^2/s.

What is the radius of a H_2O molecule?

Conceptual Questions – 30 Points Total

(15 points each, the best two will count towards your score)

(The best answers are brief and to the point, but complete. Longer answers usually mean you do not understand the topic or are not answering the question asked.)

IV. Consider the cell $|A_{(s)} | A^+_{(aq)}, Cl^-_{(aq)} || Cl^-_{(aq)}, B^+_{(aq)} | B_{(s)}|$

The cell is prepared at concentrations of $A^+_{(aq)}$ and $B^+_{(aq)}$ such that E_{cell} is –0.55 Volts. The chemical reaction is allowed to run until it reaches equilibrium.

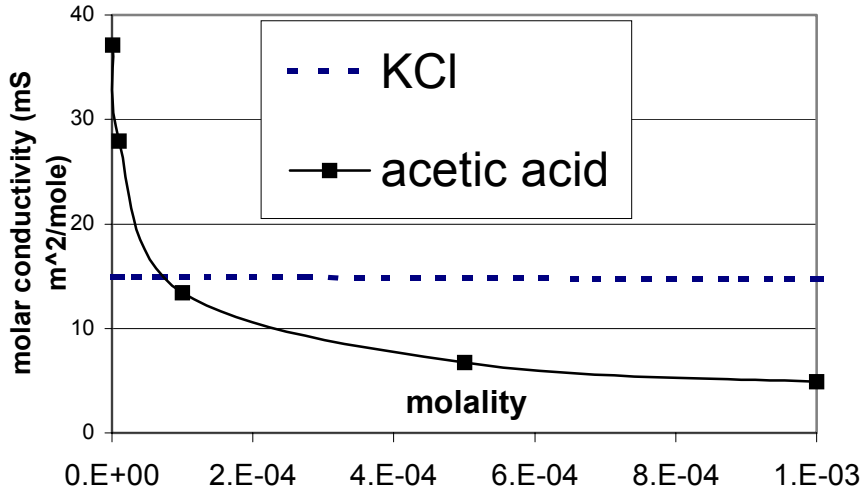
A) Which ion will be at greater concentration at equilibrium: $A^+_{(aq)}$, the $B^+_{(aq)}$, neither, or do you not have enough information to answer this question?

Explain your answers Fully!!!

V. The plot below shows the molar conductivity of KCl and acetic acid.

(A) Why is the molar conductivity of acetic acid lower than that of KCl at concentrations above about 1 x 10^{-4} molal?

(B) Why is the molar conductivity of acetic acid so much higher than that of KCl at concentrations below about 1 x 10^{-4} molal?



VI. The ionic mobility and limiting ionic conductivity of F^- in water are about 25% smaller than those of Cl^-. Why might this be so?