

## Problem Set PS11

ISSUED: 4/11/99 Due: 4/20/00

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Name \_\_\_\_\_

**Instructions.** Complete all questions before class on the due date. You are encouraged to work together. Be sure to struggle with the problem before seeking help. Many of the exercises are very similar to problems in the book. Understanding the solution to these problems will be helpful in completing the assigned exercises.

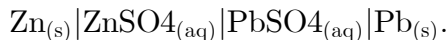
### Exercises

1. What is the ionic strength of a 1M H<sub>2</sub>SO<sub>4</sub> solution?
2. What is the ionic strength of pure water?
3. Express the relation between  $K'_{\text{base}}$  and  $K_a$ .
4. How much work is done by an electrochemical cell if it moves one mole of electrons through a 1 mV potential?
5. What are the units for the **rate** of entropy production?
6. Calculate the **rate** of entropy production for our example of the two metal blocks (§ 24.3.1), if  $T_1 = 400\text{K}$ ,  $T_2 = 300\text{K}$ ,  $\frac{dT}{dx} = 1000 \text{ K/cm}$ ,  $A = 10 \text{ cm}^2$ ,  $\kappa = 4 \frac{\text{J}}{\text{cm s K}}$
7. What is the chemical affinity  $\alpha$  for combustion of methane CH<sub>4</sub> at SATP?
8. What is the chemical affinity  $\alpha$  for the evaporation of methanol at SATP?

### Conceptual Problems

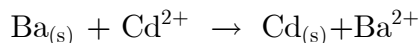
9. In your own words, explain the electrophoretic and relaxation effects as they apply to ion mobility.
10. In a photoconductivity experiment a pulsed laser is focused into a 5 cubic millimeter region of a solution of para-benzoquinone (pbq) in *n*-hexane contained between two parallel metal plates (1 cm apart). The voltage difference between the plates is 5000 V. The pulsed laser acts to ionize the pbq molecules by ejecting an electron. An amp meter timed with the pulsed laser (the pulse occurs at  $t = 0$ ) yields the trace shown below.

- (a) Assuming the laser is focused exactly between the two plates what is the velocity of the  $\text{pbq}^+$  ion?
- (b) What is the mobility of the  $\text{pbq}^+$  ion?
11. Write down the redox reaction and cell potential for



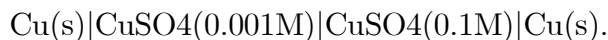
Also give the maximal amount of work this cell can produce and  $K_a$  for the reaction.

12. Write



in shorthand cell notation. Also give the maximal amount of work this cell can produce and  $K_a$  for the reaction.

13. What voltage would you expect from the following concentration cell:



assume activities are equal to concentrations.

14. Read the account of the cold fusion episode which starts on page 357 of your book.
- (a) How should the situation have been handled differently?
- (b) Can scientists make mistakes?
- (c) How do you think mistakes in science should be handled?

15. How does chapter 11 of the notes connect thermodynamics with kinetics.

16. Explain the 'local' formulation of the second law in your own words.

17. The reaction  $A \rightarrow C + D$  is described by  $\Delta_{\text{rxn}}G = 1 \text{ KJ/mol}$  and a rate law  $v = -\frac{d[A]}{dt} = 10[A]$ . Derive an expression for the rate of entropy production for this reaction at 300K. What is the total entropy production of this reaction if the initial concentration of  $A$  is 0.01 M?