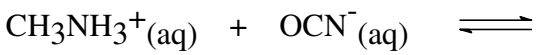
Chemistry 10123 and 10125, **Exam 3** Name: _____
March 11, 2009 (Please Print)

In the "**SHOW ALL WORK**" questions on this exam, include ***balanced, net-ionic equations for all equilibrium reactions***. ***Clearly state and justify any assumptions*** you make. Some ***selected equilibrium constants*** that are required in certain problems ***are listed on the last page*** of this exam.

1. (8 points) **SHOW ALL WORK.** Determine the molar solubility of $Mg(OH)_2$ in a solution that is buffered at pH = 8.50.

2. (10 points) **SHOW ALL WORK.** Determine the molar solubility of $Cd(OH)_2$ in a 1.50 M solution of KI.

3. (10 points) Using acid-base concepts, predict the logical products of the following reaction in aqueous solution. Write ***Lewis electron dot formulas*** (including formal charges and/or resonance forms if needed) for all reactants and products. *Clearly indicate which reactant is the Lewis acid and which is the Lewis base*. Use arrow(s) to illustrate the formation and breaking of any bonds as the reaction proceeds from left to right.



4. (7 points) **SHOW ALL WORK.** Determine the equilibrium constant (K_c) for the reaction shown in question 3 above.

5. (8 points) **SHOW ALL WORK.** A 1.50 M solution of a certain diprotic acid, H_2A, is found to have a pH of 2.10 and an A^{2-} concentration of 3.80×10^{-9} M. For this acid, pK_{a1} = _____ and pK_{a2} = _____.

6. (20 points) Indicate whether an aqueous solution of each of the following substances is acidic (A), basic (B), or neutral (N). For each solution, write a ***balanced net ionic equation for the major equilibrium reaction*** that is occurring in the solution.

   (a) $(NH_4)_2SO_4$ _____

   (b) $Mg(C_2H_3O_2)_2$ _____

   (c) $(CH_3)_2NH$ _____

   (d) $Ba(NO_3)_2$ _____

   (e) $KClO$ _____

7. (9 points) **SHOW ALL WORK.** Indium sulfide, In_2S_3 (325.8 g/mole) is so insoluble that a 20.0-L volume (about a 5-gallon can) of a saturated solution contains only 34 *pico*grams of In_2S_3. Determine K_{sp} for In_2S_3. [For those of you who have forgotten the metric system, *pico* = 10^{-12}!]

8. Assume that 500 mL of each of the following solutions (**A** - **D**) are available in your lab.

A: 2.50 M HBr

B: 1.50 M $Ba(OH)_2$

C: 0.50 M CH_3NH_3Br

D: 1.00 M $HCHO_2$

(a) (3 points) The pH of solution **A** is _____.

(b) (3 points) The pH of solution **B** is _____.

(c) (8 points) **SHOW ALL WORK.** Determine the pH of Solution **C**.

(d) (6 points) If the entire 500 mL of solution **D** is mixed with a certain volume of one of the other solutions, a ***buffer solution*** with pH = 4.00 can be produced. Which solution (**A**, **B**, or **C**) should be used for this purpose? ***Briefly explain*** your answer, including a balanced chemical equation for any reaction that occurs upon mixing your chosen solution with **D**.

(e) (8 points) **SHOW ALL WORK.** Determine the volume (in mL) of the solution you selected in part (d) that must be added to solution **D** to yield a final pH of 4.00.

Substance	**Equilibrium Constant(s)**	
$HC_2H_3O_2$	$K_a = 1.75 \times 10^{-5}$	
$HCHO_2$	$K_a = 1.80 \times 10^{-4}$	
HCN	$K_a = 6.20 \times 10^{-10}$	
HOCN	$K_a = 3.30 \times 10^{-4}$	
H_2CO_3	$K_{a1} = 4.3 \times 10^{-7}$	$K_{a2} = 5.6 \times 10^{-11}$
H_2S	$K_{a1} = 8.9 \times 10^{-8}$	$K_{a2} = 1.0 \times 10^{-19}$
NH_3	$K_b = 1.76 \times 10^{-5}$	
CH_3NH_2	$K_b = 4.42 \times 10^{-4}$	
$HONH_2$	$K_b = 9.12 \times 10^{-9}$	
$Mg(OH)_2$	$K_{sp} = 2.06 \times 10^{-13}$	
$Cd(OH)_2$	$K_{sp} = 7.2 \times 10^{-15}$	
$Cu(OH)_2$	$K_{sp} = 2.2 \times 10^{-20}$	
$In(OH)_3$	$K_{sp} = 1.3 \times 10^{-37}$	
$Au(OH)_3$	$K_{sp} = 5.5 \times 10^{-46}$	
CuS	$K_{sp} = 1.3 \times 10^{-36}$	
$CdCO_3$	$K_{sp} = 1.0 \times 10^{-12}$	
$Cd(CN)_4^{2-}$	$K_f = 3.0 \times 10^{18}$	
CdI_4^{2-}	$K_f = 2.0 \times 10^{6}$	
$Cu(NH_3)_4^{2+}$	$K_f = 1.7 \times 10^{13}$	
$Cu(CN)_4^{2-}$	$K_f = 1.0 \times 10^{29}$	