Chemistry 10123, **Exam 3** Name: _____
March 20, 2019 (Please Print)

In all of the "**SHOW ALL WORK**" questions, include ***balanced, net-ionic equations for all relevant chemical reactions and clearly indicate which ones are considered as equilibrium reactions***. ***Without the appropriate chemical reaction(s), no partial credit will be given!*** ***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. (10 points) Write a ***balanced chemical equation*** for the ***equilibrium*** reaction that corresponds to each of the following equilibrium constants. ***Indicate the proper phase (s, aq, etc.) of each species***.
   [e. g., K_w for water would be: $2\ H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$]

   (a) K_b for $H_2PO_3^-$

   (b) K_{sp} for $Mg_3(PO_4)_2$

   (c) K_b for H_2NNH_2

   (d) K_f for $Cr(C_2O_4)_3^{3-}$

   (e) K_a for $Al(H_2O)_6^{3+}$

2. (10 points) **SHOW ALL WORK.** An unknown weak base (call it RNH_2) is dissolved in enough water to make 50.0 mL of solution. This solution is then titrated with 0.125 M HNO_3 and 40.0 mL of the HNO_3 solution is required to reach the equivalence point. Using a pH meter, the pH of the solution at the equivalence point is found to be 2.94. Determine the pK_b value of the unknown base.

3. (8 points) Indicate whether an aqueous solution of each of the following substances is acidic (A), basic (B), or neutral (N).

   $NaClO_2$ _____ $(CH_3)_2NH_2Br$ _____ $Ba(NO_3)_2$ _____ HOCN _____

4. (10 points) **SHOW ALL WORK.** Indium sulfide, In_2S_3 (molar mass = 326) is so insoluble that a 2.0-L volume of a saturated solution contains only 3.4 *pico*grams of In_2S_3. Determine K_{sp} for In_2S_3. (In case you have forgotten the metric system, *pico* = 10^{-12}!)

5. (7 points) **SHOW ALL WORK.** Determine the numerical value of the equilibrium constant (K_c) for the following reaction.

   $$Cr(OH)_{3(s)} + 3\ HCO_2H_{(aq)} \rightleftharpoons Cr^{3+}_{(aq)} + 3\ HCO_2^-{}_{(aq)} + 3\ H_2O$$

6. (10 points) **SHOW ALL WORK.** By doing the appropriate calculation, determine if a precipitate will form when 75.0 mL of an NaOH solution with pH = 11.40 is mixed with 125 mL of a 0.020 M $MgCl_2$ solution. Identify the precipitate, if any.

7. In a Gen Chem lab practical, you are given four labeled bottles that contain 500 mL each of the following solutions.

A: 0.300 M KOH	**B**: 0.300 M KNO_2	**C**: 0.300 M HOBr	**D**: 0.300 M HBr
pH = _____	pH = _____	pH = _____	pH = _____

(a) (7 points) Determine the pH of each of the above solutions and fill in the blanks accordingly. (*No partial credit will be given here and work need not be shown*.)

(b) (8 points) The main task of the lab practical is to prepare a ***buffer solution*** with a pH of 4.00. Think about which ***two*** solutions you would mix together to accomplish this. (Fill in the blanks with the correct letters.) I would mix the entire 500 mL of solution _____ with a smaller volume of solution _____. ***Briefly explain*** your answers by giving specific reasons for selecting each of the two solutions. Include a ***balanced chemical equation*** for any reaction that occurs ***upon mixing*** your chosen solutions.

(c) (10 points) **SHOW ALL WORK.** Determine the volume (in mL) of the solution you selected in part (b) that must be added to 500 mL of the other solution to make the buffer with pH = 4.00.

8. (10 points) **SHOW ALL WORK.** A 3.75-g sample of codeine (a weak base with a pK_b of 5.79) was combined with 3.00 mL of 1.50 M HCl and the resulting solution was diluted to 500 mL. The measured pH of this solution was 8.46. Determine the molar mass of codeine.

9. **SHOW ALL WORK.** Determine the molar solubility of Ag_2CrO_4 in each of following solutions.

   (a) (5 points) 0.20 M $AgNO_{3(aq)}$

   (b) (10 points) 0.20 M KSCN(aq)

	IA (1)												IIIA (13)	IVA (14)	VA (15)	VIA (16)	VIIA (17)	VIIIA (18)
1	1 **H** 1.0080	IIA (2)																2 **He** 4.0026
2	3 **Li** 6.9410	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.179
3	11 **Na** 22.990	12 **Mg** 24.305	IIIB (3)	IVB (4)	VB (5)	VIB (6)	VIIB (7)	. . . . . (8)	VIIIB (9)	. . . . . (10)	IB (11)	IIB (12)	13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
4	19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.880	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.690	29 **Cu** 63.546	30 **Zn** 65.380	31 **Ga** 69.723	32 **Ge** 72.610	33 **As** 74.922	34 **Se** 78.960	35 **Br** 79.904	36 **Kr** 83.800
5	37 **Rb** 85.468	38 **Sr** 87.620	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.940	43 **Tc** 98.907	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
6	55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.20	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.20	83 **Bi** 208.98	84 **Po** 208.98	85 **At** 209.99	86 **Rn** 222.02
7	87 **Fr** 223.02	88 **Ra** 226.03	89 **Ac** 227.03	104 Unq 261.11	105 Unp 262.11	106 Unh 263.12	107 Uns 262.12											

Substance	**Equilibrium Constant(s)**	
CH_3CO_2H	$K_a = 1.75 \times 10^{-5}$	
HCO_2H	$K_a = 1.80 \times 10^{-4}$	
HOBr	$K_a = 2.80 \times 10^{-9}$	
HNO_2	$K_a = 4.60 \times 10^{-4}$	
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	$K_b = 4.42 \times 10^{-4}$	
$HONH_2$	$K_b = 9.12 \times 10^{-9}$	
$Mg(OH)_2$	$K_{sp} = 2.06 \times 10^{-13}$	
$Cd(OH)_2$	$K_{sp} = 7.2 \times 10^{-15}$	
$Cr(OH)_3$	$K_{sp} = 6.3 \times 10^{-31}$	
$Cu(OH)_2$	$K_{sp} = 2.2 \times 10^{-20}$	
$Au(OH)_3$	$K_{sp} = 5.5 \times 10^{-46}$	
Ag_2S	$K_{sp} = 6.0 \times 10^{-51}$	
Ag_2CrO_4	$K_{sp} = 1.12 \times 10^{-12}$	
$CdCO_3$	$K_{sp} = 1.0 \times 10^{-12}$	
$Cd(CN)_4^{2-}$	$K_f = 3.0 \times 10^{18}$	
$Cu(NH_3)_4^{2+}$	$K_f = 1.7 \times 10^{13}$	
$Ag(CN)_2^-$	$K_f = 1.0 \times 10^{21}$	
$Ag(SCN)_2^-$	$K_f = 1.2 \times 10^{10}$	
$Cu(CN)_4^{2-}$	$K_f = 1.0 \times 10^{29}$	