Name: ____________________

Chem 2113 Test 2 Spring 2005

Questions are worth 25 points each. OMIT ONE QUESTION by clearly writing OMIT in the space provided for your work. If you fail to mark OMIT on a question I will omit the last question of the test. Show your work and circle your answers for full credit.

1. Calculate the pH of the following solutions:

   2.74×10^{-3} M $LiClO_4$

   7.00

   15.0 mL of 0.0124 M NaOH mixed with 20.0 mL of 0.0108 M HCl

   3.07

   20.0 mL of 0.150 M HNO_2 mixed with 30.0 mL of 0.100 M $NaNO_2$

   3.29

   0.215 M NaHS

   10.98

   0.025 M H_2SO_4

   1.50

2. Consider the titration of 25.0 mL of 0.10 M sodium carbonate with 0.10 M HCl. Calculate the pH of the solution at the following points along the titration curve:

a) Before any titrant is added;

11.66

b) After 12.5 mL of titrant is added;

10.32

c) After 25.0 mL of titrant is added;

8.34

d) After 37.5 mL of titrant is added;

6.37

e) After 50.0 mL of titrant is added.

3.92

3. Consider the titration of 25.0 mL of 0.10 M boric acid with 0.050 M NaOH. Calculate the pH of the solution at the following points along the titration curve:

a) Before any titrant is added;

5.10

b) After 25.0 mL of titrant is added;

9.19

c) After 40.0 mL of titrant is added;

9.80

d) After 50.0 mL of titrant is added;

10.86

e) After 60.0 mL of titrant is added.

11.77

4. A cyanide solution with a volume of 13.72 mL was treated with 25.00 mL of Ni^{2+} solution(which contained an excess of Ni(II) ions) to convert the cyanide to the complex ion tetracyanonickelate(II):

$$4CN^- + Ni^{2+} \rightarrow Ni(CN)_4^{2-}$$

The excess Ni^{2+} was then titrated with 10.15 mL of 0.01307 M EDTA. One mole of this reagent reacts with one mole of Ni(II) as follows:

$$Ni^{2+} + EDTA^{4-} \rightarrow Ni(EDTA)^{2-}$$

$Ni(CN)_4^{2-}$ does not react with EDTA. If 39.35 mL of EDTA was required to react with 30.10 mL of the original Ni^{2+} solution, calculate the molarity of CN^- in the 13.72 mL cyanide sample.

0.08586 M CN^-

5. One of the assumptions that we make when dealing with polyprotic acids is that "all of the first proton reacts before any of the second proton" and so forth. In reality, there will be at least some of all of the forms of the acid present at any point in the reaction - a more correct statement would be that no *significant* amount of the second proton reacts before essentially all of the first proton reacts, and so forth. Determine the validity of this assumption for a 0.050 M solution of sulfurous acid at a pH of 4.593 (which corresponds to the pH of the first equivalence point in the titration of this diprotic acid) by calculating the fractional amount of H_2SO_3, HSO_3^-, and SO_3^{2-} that are present at this pH.

   α_0 = 0.002 (fractional amount of H_2SO_3)

   α_1 = 0.995 (fractional amount of HSO_3^-)

   α_2 = 0.003 (fractional amount of SO_3^{2-})

Acid Dissociation Constants

NAME	FORMULA	K_1	K_2	K_3
Acetic	$HC_2H_3O_2$	1.75×10^{-5}		
Alanine	$CH_3CH(NH_2)COOH$	4.5×10^{-3}	1.3×10^{-10}	
Arsenic	H_3AsO_4	6.0×10^{-3}	1.0×10^{-7}	3.0×10^{-12}
Arsenious	H_3AsO_3	6.0×10^{-10}	3.0×10^{-14}	
Benzoic	C_6H_5COOH	6.3×10^{-5}		
Boric	H_3BO_3	6.4×10^{-10}		
Carbonic	H_2CO_3	4.3×10^{-7}	4.8×10^{-11}	
Chloroacetic	$ClCH_2COOH$	1.51×10^{-3}		
Citric	$HOOC(OH)C(CH_2COOH)_2$	7.4×10^{-4}	1.7×10^{-5}	4.0×10^{-7}
Formic	$HCOOH$	1.76×10^{-4}		
Glycine	H_2NCH_2COOH	4.5×10^{-3}	1.7×10^{-10}	
Hydrocyanic	HCN	7.2×10^{-10}		
Hydrofluoric	HF	6.7×10^{-4}		
Hydrogen sulfide	H_2S	9.1×10^{-8}	1.2×10^{-15}	
Hypochlorous	$HOCl$	3.0×10^{-8}		
Iodic	HIO_3	$2. \times 10^{-1}$		
Lactic	$CH_3CHOHCOOH$	1.4×10^{-4}		
Leucine	$(CH_3)_2CHCH_2CH(NH_2)COOH$	4.7×10^{-3}	1.8×10^{-10}	
Maleic	cis-HOOCCH:CHCOOH	1.5×10^{-2}	2.6×10^{-7}	
Malic	$HOOCCHOHCH_2COOH$	4.0×10^{-4}	8.9×10^{-6}	
Nitrous	HNO_2	5.1×10^{-4}		
Oxalic	$HOOCCOOH$	6.5×10^{-2}	6.1×10^{-5}	
Phenol	C_6H_5OH	1.1×10^{-10}		
Phosphoric	H_3PO_4	1.1×10^{-2}	7.5×10^{-8}	4.8×10^{-13}
Phosphorous	H_3PO_3	$5. \times 10^{-2}$	2.6×10^{-7}	
o-Phthalic	$C_6H_4(COOH)_2$	1.2×10^{-3}	3.9×10^{-6}	
Picric	$(NO_2)_3C_6H_5OH$	4.2×10^{-1}		
Propanoic	CH_3CH_2COOH	1.3×10^{-5}		
Salicylic	$C_6H_4(OH)COOH$	1.0×10^{-3}		
Sulfamic	NH_2SO_3H	1.0×10^{-1}		
Sulfuric	H_2SO_4	>>1	1.2×10^{-2}	
Sulfurous	H_2SO_3	1.23×10^{-2}	6.6×10^{-8}	
Trichloroacetic	$HC_2Cl_3O_2$	1.29×10^{-1}		

Base Dissociation Constants

NAME	FORMULA	K_1	K_2
Ammonia	NH_3	1.75×10^{-5}	
Aniline	$C_cH_5NH_2$	4.0×10^{-10}	
1-Butylamine	$CH_3(CH_2)_2CH_2NH_2$	4.1×10^{-4}	
Diethylamine	$(CH_3CH_2)_2NH$	8.5×10^{-4}	
Dimethylamine	$(CH_3)_2NH$	5.9×10^{-4}	
Ethanolamine	$HOC_2H_4NH_2$	3.2×10^{-5}	
Ethylamine	$CH_3CH_2NH_2$	4.3×10^{-4}	
Ethylenediamine	$NH_2C_2H_4NH_2$	8.5×10^{-5}	7.1×10^{-8}
Glycine	$HOOCCH_2NH_2$	2.3×10^{-12}	
Hydrazine	H_2NNH_2	1.3×10^{-6}	
Hydroxylamine	$HONH_2$	9.1×10^{-9}	
Methylamine	CH_3NH_2	4.8×10^{-4}	
Piperidine	$C_5H_{11}N$	1.3×10^{-3}	
Pyridine	C_6H_5N	$1.7 \text{ X } 10^{-9}$	
Triethylamine	$(CH_3CH_3)_3N$	5.3×10^{-4}	
Trimethylamine	$(CH_3)_3N$	6.3×10^{-5}	
Tris(hydroxymethyl)aminomethane (TRIS, THAM)	$(HOCH_2)_3CNH_2$	1.2×10^{-6}	
Zinc Hydroxide	$Zn(OH)_2$	4.4×10^{-5}	