

Name: \_\_\_\_\_

Chem 2113

Test 2

March 12, 2003

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. GOOD LUCK!

Calculate the pH of the following solutions/mixtures:

0.030 M  $\text{HNO}_3$

1.52

0.025 M piperidine

11.71

The solution that results when 25.0 mL of 0.100 M acetic acid is mixed with 15.0 mL of 0.075 M NaOH.

4.67

0.200 M potassium hydrogen phthalate

4.16

0.040 M  $\text{H}_2\text{SO}_4$

1.32

2. Consider the titration of 50.0 mL of 0.050 M phenol 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;

5.63

b) After 15.0 mL of titrant is added;

9.59

c) After 25.0 mL of titrant is added;

9.96

d) After 50.0 mL of titrant is added;

11.18

e) After 60.0 mL of titrant is added.

11.66

3. Consider the titration of 25.0 mL of 0.20 M ethylene diamine with 0.20 M HCl. Calculate the pH of the solution at the following points along the titration curve:

a) Before any titrant is added;

11.62

b) After 12.5 mL of titrant is added;

9.93

c) After 25.0 mL of titrant is added;

8.39

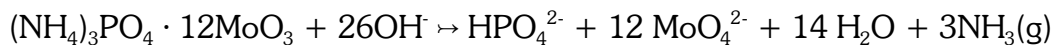
d) After 37.5 mL of titrant is added;

6.85

e) After 50.0 mL of titrant is added.

4.36

4. The digestion of a 0.1432 g sample of a compound containing phosphorous in a mixture of  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  resulted in the formation of  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ , and  $\text{H}_3\text{PO}_4$ . Addition of ammonium molybdate yielded a solid having the composition  $(\text{NH}_4)_3\text{PO}_4 \cdot 12\text{MoO}_3$  (MW=1876.3 g/mol). This precipitate was filtered, washed, and dissolved in 50.00 mL of 0.2000 M NaOH:



After the solution was boiled to remove the  $\text{NH}_3$ , the excess NaOH was titrated with 14.71 mL of 0.1741 M HCl to a phenolphthalein end point. Calculate the percentage of phosphorous in the sample.

6.19% P

5. Consider a mixture that may contain NaOH (39.997), Na<sub>2</sub>CO<sub>3</sub> (105.989), NaHCO<sub>3</sub> (84.007) and NaCl (58.442). A 4.147 g sample of the mixture was dissolved and diluted to 500.0 mL. A 50.00 mL aliquot of this solution was titrated to a phenolphthalein endpoint, which required 34.68 mL of 0.1247 M HCl. A second 50.00 mL aliquot was titrated to a bromocresolgreen endpoint with 45.41 mL of the titrant. Determine the identity of the component(s), and calculate the percentage (of each) present in the original mixture.

Components are NaOH and Na<sub>2</sub>CO<sub>3</sub>

28.80% NaOH

34.20% Na<sub>2</sub>CO<sub>3</sub>

## Acid Dissociation Constants

NAME	FORMULA	$K_1$	$K_2$	$K_3$
Acetic	CH <sub>3</sub> COOH	$1.75 \times 10^{-5}$		
Alanine	CH <sub>3</sub> CH(NH <sub>2</sub> )COOH	$4.5 \times 10^{-3}$	$1.3 \times 10^{-10}$	
Arsenic	H <sub>3</sub> AsO <sub>4</sub>	$6.0 \times 10^{-3}$	$1.0 \times 10^{-7}$	$3.0 \times 10^{-12}$
Arsenious	H <sub>3</sub> AsO <sub>3</sub>	$6.0 \times 10^{-10}$	$3.0 \times 10^{-14}$	
Benzoic	C <sub>6</sub> H <sub>5</sub> COOH	$6.3 \times 10^{-5}$		
Boric	H <sub>3</sub> BO <sub>3</sub>	$6.4 \times 10^{-10}$		
Carbonic	H <sub>2</sub> CO <sub>3</sub>	$4.3 \times 10^{-7}$	$4.8 \times 10^{-11}$	
Chloroacetic	ClCH <sub>2</sub> COOH	$1.51 \times 10^{-3}$		
Citric	HOOC(OH)C(CH <sub>2</sub> COOH) <sub>2</sub>	$7.4 \times 10^{-4}$	$1.7 \times 10^{-5}$	$4.0 \times 10^{-7}$
Formic	HCOOH	$1.76 \times 10^{-4}$		
Glycine	H <sub>2</sub> NCH <sub>2</sub> COOH	$4.5 \times 10^{-3}$	$1.7 \times 10^{-10}$	
Hydrocyanic	HCN	$7.2 \times 10^{-10}$		
Hydrofluoric	HF	$6.7 \times 10^{-4}$		
Hydrogen sulfide	H <sub>2</sub> S	$9.1 \times 10^{-8}$	$1.2 \times 10^{-15}$	
Hypochlorous	HOCl	$3.0 \times 10^{-8}$		
Iodic	HIO <sub>3</sub>	$2. \times 10^{-1}$		
Lactic	CH <sub>3</sub> CHOHCOOH	$1.4 \times 10^{-4}$		
Leucine	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> CH(NH <sub>2</sub> )COOH	$4.7 \times 10^{-3}$	$1.8 \times 10^{-10}$	
Maleic	cis-HOOCCH:CHCOOH	$1.5 \times 10^{-2}$	$2.6 \times 10^{-7}$	
Malic	HOOCCHOHCH <sub>2</sub> COOH	$4.0 \times 10^{-4}$	$8.9 \times 10^{-6}$	
Nitrous	HNO <sub>2</sub>	$5.1 \times 10^{-4}$		
Oxalic	HOOC <sub>2</sub> COOH	$6.5 \times 10^{-2}$	$6.1 \times 10^{-5}$	
Phenol	C <sub>6</sub> H <sub>5</sub> OH	$1.1 \times 10^{-10}$		
Phosphoric	H <sub>3</sub> PO <sub>4</sub>	$1.1 \times 10^{-2}$	$7.5 \times 10^{-8}$	$4.8 \times 10^{-13}$
Phosphorous	H <sub>3</sub> PO <sub>3</sub>	$5. \times 10^{-2}$	$2.6 \times 10^{-7}$	
o-Phthalic	C <sub>6</sub> H <sub>4</sub> (COOH) <sub>2</sub>	$1.2 \times 10^{-3}$	$3.9 \times 10^{-6}$	
Picric	(NO <sub>2</sub> ) <sub>3</sub> C <sub>6</sub> H <sub>5</sub> OH	$4.2 \times 10^{-1}$		
Propanoic	CH <sub>3</sub> CH <sub>2</sub> COOH	$1.3 \times 10^{-5}$		
Salicylic	C <sub>6</sub> H <sub>4</sub> (OH)COOH	$1.0 \times 10^{-3}$		
Sulfamic	NH <sub>2</sub> SO <sub>3</sub> H	$1.0 \times 10^{-1}$		
Sulfuric	H <sub>2</sub> SO <sub>4</sub>	>>1	$1.2 \times 10^{-2}$	
Sulfurous	H <sub>2</sub> SO <sub>3</sub>	$1.23 \times 10^{-2}$	$6.6 \times 10^{-8}$	
Trichloroacetic	Cl <sub>3</sub> COOH	$1.29 \times 10^{-1}$		

## Base Dissociation Constants

NAME	FORMULA	$K_1$	$K_2$
Ammonia	NH <sub>3</sub>	$1.75 \times 10^{-5}$	
Aniline	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	$4.0 \times 10^{-10}$	
1-Butylamine	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub>	$4.1 \times 10^{-4}$	
Diethylamine	(CH <sub>3</sub> CH <sub>2</sub> ) <sub>2</sub> NH	$8.5 \times 10^{-4}$	
Dimethylamine	(CH <sub>3</sub> ) <sub>2</sub> NH	$5.9 \times 10^{-4}$	
Ethanolamine	HOC <sub>2</sub> H <sub>4</sub> NH <sub>2</sub>	$3.2 \times 10^{-5}$	
Ethylamine	CH <sub>3</sub> CH <sub>2</sub> NH <sub>2</sub>	$4.3 \times 10^{-4}$	
Ethylenediamine	NH <sub>2</sub> C <sub>2</sub> H <sub>4</sub> NH <sub>2</sub>	$8.5 \times 10^{-5}$	$7.1 \times 10^{-8}$
Glycine	HOOCCH <sub>2</sub> NH <sub>2</sub>	$2.3 \times 10^{-12}$	
Hydrazine	H <sub>2</sub> NNH <sub>2</sub>	$1.3 \times 10^{-6}$	
Hydroxylamine	HONH <sub>2</sub>	$9.1 \times 10^{-9}$	
Methylamine	CH <sub>3</sub> NH <sub>2</sub>	$4.8 \times 10^{-4}$	
Piperidine	C <sub>5</sub> H <sub>11</sub> N	$1.3 \times 10^{-3}$	
Pyridine	C <sub>6</sub> H <sub>5</sub> N	$1.7 \times 10^{-9}$	
Triethylamine	(CH <sub>3</sub> CH <sub>2</sub> ) <sub>3</sub> N	$5.3 \times 10^{-4}$	
Trimethylamine	(CH <sub>3</sub> ) <sub>3</sub> N	$6.3 \times 10^{-5}$	
Tris(hydroxymethyl)aminomethane (TRIS, THAM)	(HOCH <sub>2</sub> ) <sub>3</sub> CNH <sub>2</sub>	$1.2 \times 10^{-6}$	
Zinc Hydroxide	Zn(OH) <sub>2</sub>	$4.4 \times 10^{-5}$	