CHEM 1515 Sections 20511 and 20516
Exam III
John III. Gelder

Name _____

TA's Name _____

Section _____

INSTRUCTIONS:

1. This examination consists of a total of 12 different pages. The last three pages include a periodic table, a solubility table and a table of equilibrium values. All work should be done in this booklet.

2. PRINT your name, TA's name and your lab section number now in the space at the top of this sheet. DO NOT SEPARATE THESE PAGES.

3. Answer all questions that you can and whenever called for show your work clearly. Your method of solving problems should pattern the approach used in lecture. You do not have to show your work for the multiple choice or short answer questions.

4. No credit will be awarded if your work is not shown in 3 and 4.

5. Point values are shown next to the problem number.

6. Budget your time for each of the questions. Some problems may have a low point value yet be very challenging. If you do not recognize the solution to a question quickly, skip it, and return to the question after completing the easier problems.

7. Look through the exam before beginning; plan your work; then begin.

8. Relax and do well.

	Page 2	Page 3	Page 4	MC	TOTAL
SCORES	_____	_____	_____	_____	_____

(9) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous. Soluble ionic compounds should be written in the form of their component ions.

a) $HNO_{3(aq)} + Ca(OH)_{2(aq)} \rightarrow$

b) $HC_2H_3O_{2(aq)} + C_2H_5NH_{2(aq)} \rightarrow$

c) $HC_3H_5O_{3(aq)} + KOH_{(aq)} \rightarrow$

(4) 2a. Write the ionic and net ionic chemical equation for 1c).

Ionic equation

Net Ionic equation

(38) 3. Calculate the pH

a) 2.5×10^{-3} M $HClO_4$ **(Answer: pH = 2.60)**

b) 0.418 M $(CH_3)_2NH$ **(Answer: pH = 12.18)**

c) 0.125 M $C_2H_5NH_3NO_3$ **(Answer: pH = 5.85)**

d) 0.368 M $HC_3H_5O_2$ (propionic acid) and 0.294 M $KC_3H_5O_2$ **(Answer: pH = 4.79)**

(20) 4. 500.0 mL of a buffer solution is 0.250 M $HC_2H_3O_2$ and 0.300 M $KC_2H_3O_2$.

a) Calculate the pH of this solution **(Answer: pH = 4.82)**

b) Calculate the pH of the solution after adding 0.0300 mol of NaOH to the solution in part a). (Assume no change in the volume after adding the base to the buffer.) **(Answer: pH = 5.02)**

(18) 5. Calculate the pH when

a) 25.00 mL of 0.400 M NH_3 is added to 40.0 mL of 0.250 M HCl **(Answer: pH = 5.03)**

b) 60.00 mL of 0.400 M HCl is added to 80.0 mL of 0.320 M KOH **(Answer: pH = 12.06)**

Short Answer:

(5) 5. Is a solution that is 0.100 M HCN and 0.100 M KCN acidic or basic? Explain.

(5) 6. The pH of a 3.72×10^{-4} M solution of a base is 10.87. Is the base strong or weak? Explain.

Multiple Choice: (30 points)

Print the letter (A, B, C, D, E) which corresponds to the answer selected.

7. _____ 8. _____ 9. _____ 10. _____

11. _____ 12. _____ 13. _____ 14. _____

15. _____ 16. _____

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 3 points.

7. An aqueous solution that is 1.00×10^{-2} M strychnine has a pH of 10.00. K_b for strychnine is

(A) 1.0×10^{-4}
(B) 1.0×10^{-6}
(C) 1.0×10^{-8}
(D) 1.0×10^{-10}
(E) 1.0×10^{-12}

8. If the acid dissociation constant, K_a, for an acid HA is 8.0×10^{-4} at 25 °C, what percent of the acid is dissociated in a 0.50-molar solution of HA at 25 °C?

   (A) 0.2%
   (B) 1%
   (C) 2%
   (D) 4%
   (E) 98%

9. What is the pH of a 1.00 M H_3PO_4 solution?

   (A) -0.477
   (B) 0
   (C) 1.08
   (D) 2.12
   (E) 7.00

10. Which of the following can act as an acid or as a base in aqueous solution?

   (A) NH_4^+
   (B) CN^-
   (C) H_2SO_4
   (D) SO_4^{2-}
   (E) HSO_4^-

11. H_2CO_3 is a diprotic acid. ($K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$) Which of the following species is present in the highest concentration in an aqueous solution that is 0.0100 M H_2CO_3?

(A) H_2CO_3
(B) H^+
(C) HCO_3^-
(D) CO_3^{2-}
(E) OH^-

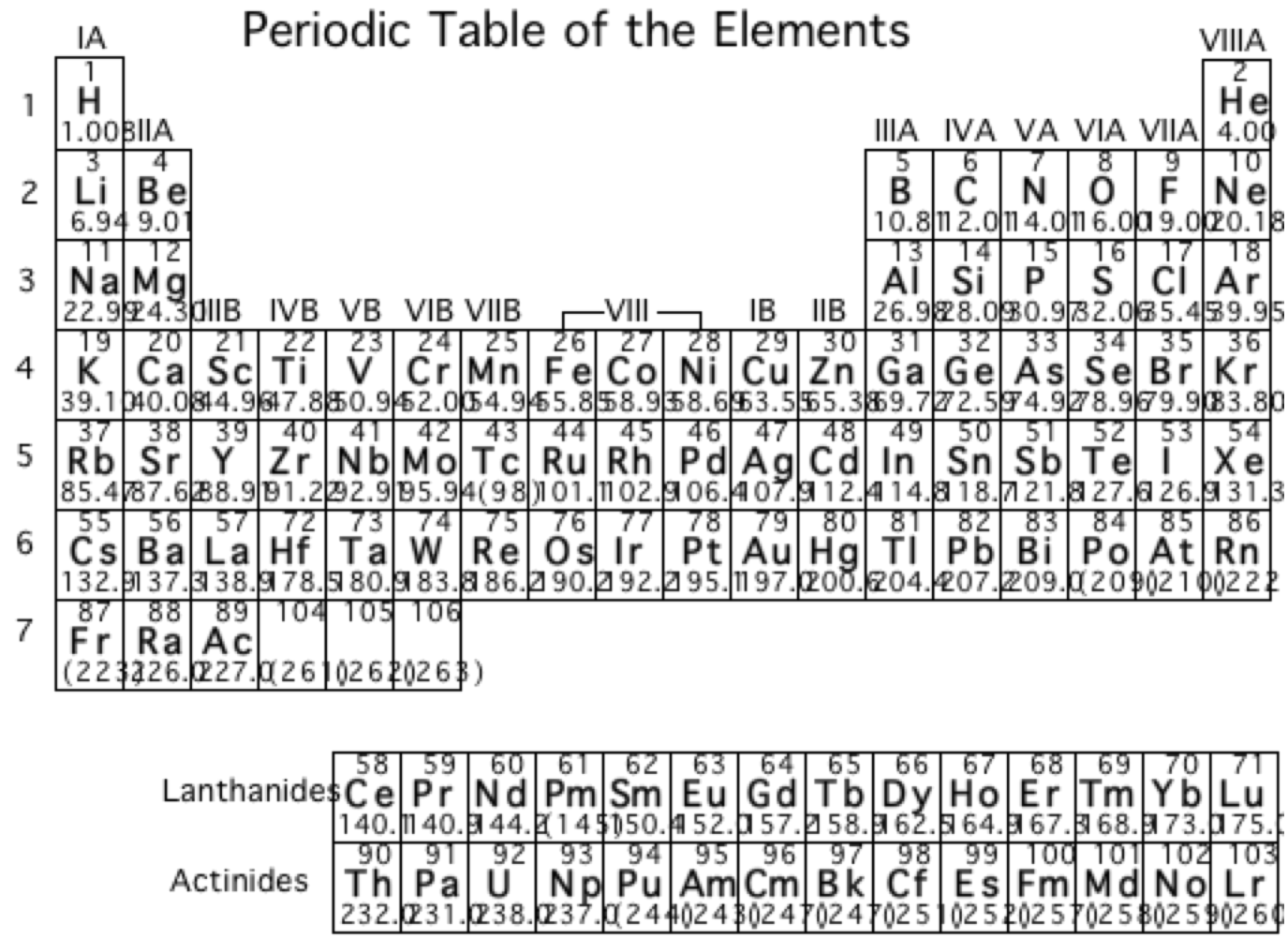
12. A 1-molar solution of which of the following salts has the highest pH ?

(A) $NaNO_3$
(B) NH_4Cl
(C) Na_2CO_3
(D) $NaHSO_4$
(E) Na_2SO_4

13. $$H_2PO_4^- + HBO_3^{2-} \rightleftharpoons HPO_4^{2-} + H_2BO_3^-$$

The equilibrium constant for the reaction represented by the equation above is greater than 1.0. Which of the following gives the correct relative strengths of the acids and bases in the reaction in terms of a Bronsted-Lowry definition of acids and bases?

	Acids		Bases
(A)	**$H_2PO_4^- > H_2BO_3^-$**	**and**	**$HBO_3^{2-} > HPO_4^{2-}$**
(B)	$H_2BO_3^- > H_2PO_4^-$	and	$HBO_3^{2-} > HPO_4^{2-}$
(C)	$H_2PO_4^- > H_2BO_3^-$	and	$HPO_4^{2-} > HBO_3^{2-}$
(D)	$H_2BO_3^- > H_2PO_4^-$	and	$HPO_4^{2-} > HBO_3^{2-}$
(E)	$H_2PO_4^- = H_2BO_3^-$	and	$HPO_4^{2-} = HBO_3^{2-}$



Useful Information

$pH = -\log[H^+]$ $pOH = -\log[OH^-]$ $pH + pOH = 14$

$K_w = 1.00 \times 10^{-14}$

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{for} \quad ax^2 + bx + c = 0$$

Name	Formula	K_{a1}	K_{a2}	K_{a3}
Acetic	$HC_2H_3O_2$	1.8×10^{-5}		
Ascorbic	$HC_6H_7O_6$	8.0×10^{-3}		
Arsenic	H_3AsO_4	5.6×10^{-3}	1.0×10^{-7}	3.0×10^{-12}
Arsenous	H_3AsO_3	6.0×10^{-10}		
Benzoic	$HC_7H_5O_2$	6.5×10^{-5}		
Butyric acid	$HC_4H_7O_2$	1.5×10^{-5}		
Carbonic	H_2CO_3	4.3×10^{-7}	5.6×10^{-11}	
Cyanic	HCNO	3.5×10^{-4}		
Citric	$H_3C_6H_5O_7$	7.4×10^{-4}	1.7×10^{-5}	4.0×10^{-7}
Formic	$HCHO_2$	1.8×10^{-4}		
Hydroazoic	HN_3	1.9×10^{-5}		
Hydrocyanic	HCN	4.9×10^{-10}		
Hydrofluoric	HF	7.2×10^{-4}		
Hydrogen chromate ion	$HCrO_4^-$	3.0×10^{-7}		
Hydrogen peroxide	H_2O_2	2.4×10^{-12}		
Hydrogen selenate ion	$HSeO_4^-$	2.2×10^{-2}		
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}		
Hydrogen sulfide	H_2S	5.7×10^{-8}	1.3×10^{-13}	
Hypobromous	HBrO	2.0×10^{-9}		
Hypochlorous	HClO	3.0×10^{-8}		
Hypoiodus	HIO	2.0×10^{-11}		
Iodic	HIO_3	1.7×10^{-1}		
Lactic	$HC_3H_5O_3$	1.4×10^{-4}		
Malonic	$H_2C_3H_2O_4$	1.5×10^{-3}	2.0×10^{-6}	
Oxalic	$H_2C_2O_4$	5.9×10^{-2}	6.4×10^{-5}	
Nitrous	HNO_2	4.5×10^{-4}		
Phenol	HC_6H_5O	1.3×10^{-10}		
Phosphoric	H_3PO_4	7.5×10^{-3}	6.2×10^{-8}	4.2×10^{-13}
Paraperiodic	H_5IO_6	2.8×10^{-2}	5.3×10^{-9}	
Propionic	$HC_3H_5O_2$	1.3×10^{-5}		
Pyrophosphoric	H_4P_2O	3.0×10^{-2}	4.4×10^{-3}	
Selenous	H_2SeO_3	2.3×10^{-3}	5.3×10^{-9}	
Sulfuric	H_2SO_4	strong acid	1.2×10^{-2}	
Sulfurous	H_2SO_3	1.7×10^{-2}	6.4×10^{-8}	
Tartaric	$H_2C_4H_4O_6$	1.0×10^{-3}	4.6×10^{-5}	

E.2 DISSOCIATION CONSTANTS FOR BASES AT 25°C

Name	Formula	K_b	Name	Formula	K_b
Ammonia	NH_3	1.8×10^{-5}	Hydroxylamine	$HONH_2$	1.1×10^{-8}
Aniline	$C_6H_5NH_2$	4.3×10^{-10}	Methylamine	CH_3NH_2	4.4×10^{-4}
Dimethylamine	$(CH_3)_2NH$	5.4×10^{-4}	Pyridine	C_5H_5N	1.7×10^{-9}
Ethylamine	$C_2H_5NH_2$	6.4×10^{-4}	Trimethylamine	$(CH_3)_3N$	6.4×10^{-5}
Hydrazine	H_2NNH_2	1.3×10^{-6}			

Solubility Table

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+, Hg_2^{2+}, *Pb^{2+}
I^-	soluble	except Ag^+, Hg_2^{2+}, Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
^-OH	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble