

CHEM 1515.001
Exam IV
John IV. Gelder
May 8, 2001

Name _____

TA's Name _____

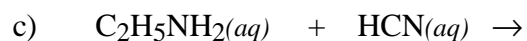
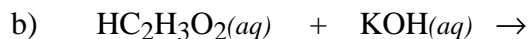
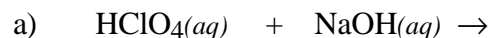
Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last three pages include a periodic table, some useful mathematical equations, a solubility table and a table of equilibrium constants. 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 problems 3, 5, 6b and 7.
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	Page 5	Page 6	TOTAL
SCORES	_____	_____	_____	_____	_____	_____
	(23)	(20)	(30)	(9)	(16)	(100)

(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.



(8) 2. Write the ionic and net ionic chemical equations for 1a) and 1b).

1a)

Ionic equation:

Net Ionic equation:

1b)

Ionic equation:

Net Ionic equation:

(6) 3. Calculate the magnitude of the equilibrium constant for 1a and 1b.

Short Answer: (4 points each)

(20) 4a. For each of the following acids, write the formula for the conjugate base.



b) For each of the following bases, write the formula for the conjugate acid.



c) Write a chemical equation describing how NaHC_2O_4 behaves as an acid.

d) Write a chemical equation describing how NaHC_2O_4 behaves as a base.

e) Does NaHC_2O_4 behave as an acid or base when added to water? Explain.

(30) 5. Calculate the pH for each of the following solution;

a) 0.675 M $\text{Sr}(\text{OH})_2$

b) 0.250 M $\text{HC}_7\text{H}_5\text{O}_2$ (benzoic acid)

c) 0.430 M $\text{KC}_6\text{H}_5\text{O}$ (phenol)

- (9) 6. A 1.50×10^{-3} mol sample of acetylsalicylic acid was dissolved in 12.50 mL of water and then titrated with 0.150 M NaOH. Given that acetylsalicylic acid is a monoprotic acid and using the data from the titration shown in the table below,

Volume of 0.100 M NaOH added (mL)	pH
0.00	2.20
2.50	2.96
5.00	3.44
7.50	3.92
10.00	8.05
12.50	?

Determine;

- a) the value of K_a for acetylsalicylic acid;
- b) the pH of the solution after a total volume of 12.50 mL of the NaOH solution has been added. (Note: assume the volumes are additive.)

(16) 7. Calculate the pH of a solution prepared by adding 0.250 mol of CH_3NH_2 and 0.225 mol of $\text{CH}_3\text{NH}_3\text{NO}_3$ to 1.00 L of water. (Assume no volume change.)

Calculate

a) the initial pH of the solution

b) the pH of the solution after adding 0.0100 mol of HCl to the solution.

Periodic Table of the Elements

	IA																VIII A	
1	1 H 1.008																	2 He 4.00
		IIA										IIIA	IVA	VA	VIA	VIIA		
2	3 Li 6.94	4 Be 9.01										5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
3	11 Na 22.99	12 Mg 24.30										13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95	
			IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB						
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Useful Information

$$K_w = 1.0 \times 10^{-14}$$

$$\text{pH} = -\log[\text{H}^+]$$

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

$$6.023 \times 10^{23}$$

E.1 DISSOCIATION CONSTANTS FOR ACIDS AT 25 °C

Name	Formula	K_{a1}	K_{a2}	K_{a3}
Acetic	$\text{HC}_2\text{H}_3\text{O}_2$	1.8×10^{-5}		
Ascorbic	$\text{HC}_6\text{H}_7\text{O}_6$	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	$\text{HC}_7\text{H}_5\text{O}_2$	6.5×10^{-5}		
Boric	H_3BO_3	5.8×10^{-10}		
Butyric acid	$\text{HC}_4\text{H}_7\text{O}_2$	1.5×10^{-5}		
Carbonic	H_2CO_3	4.3×10^{-7}	5.6×10^{-11}	
Cyanic	HCNO	3.5×10^{-4}		
Citric	$\text{H}_3\text{C}_6\text{H}_5\text{O}_7$	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}		
Hypoiodous	HIO	2.0×10^{-11}		
Iodic	HIO_3	1.7×10^{-1}		
Lactic	$\text{HC}_3\text{H}_5\text{O}_3$	1.4×10^{-4}		
Malonic	$\text{H}_2\text{C}_3\text{H}_2\text{O}_4$	1.5×10^{-3}	2.0×10^{-6}	
Oxalic	$\text{H}_2\text{C}_2\text{O}_4$	5.9×10^{-2}	6.4×10^{-5}	
Nitrous	HNO_2	4.5×10^{-4}		
Phenol	$\text{HC}_6\text{H}_5\text{O}$	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	$\text{HC}_3\text{H}_5\text{O}_2$	1.3×10^{-5}		
Pyrophosphoric	$\text{H}_4\text{P}_2\text{O}_7$	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	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	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	$\text{C}_6\text{H}_5\text{NH}_2$	4.3×10^{-10}	Methylamine	CH_3NH_2	4.4×10^{-4}
Dimethylamine	$(\text{CH}_3)_2\text{NH}$	5.4×10^{-4}			
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2$	6.4×10^{-4}	Trimethylamine	$(\text{CH}_3)_3\text{N}$	6.4×10^{-5}
Hydrazine	H_2NNH_2	1.3×10^{-6}			

Solubility Table

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
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