

CHEM 1515.001 - 006
Exam III
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April 16, 2002

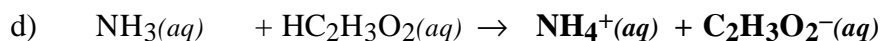
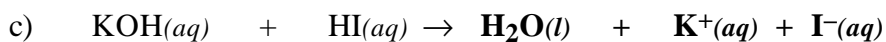
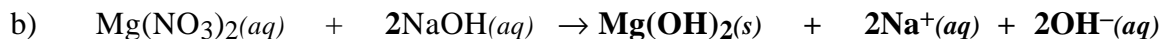
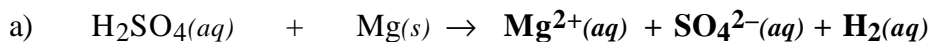
Name _____
TA's Name _____
Section _____

INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last three pages include a periodic table, a table of equilibrium constants, a solubility table and some useful equations. 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, 5 and 6.
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	TOTAL
SCORES	<u> </u> (26)	<u> </u> (16)	<u> </u> (36)	<u> </u> (22)	<u> </u> (100)

(12) 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.

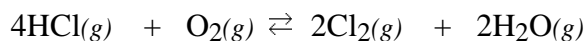


(4) 2a. Write the ionic and net ionic chemical equation for 1a), 1b), 1c) or 1d).

Ionic equation

Net Ionic equation

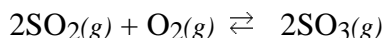
(10) 3. At high temperature HCl and O₂ react to give Cl₂ gas:



2.30 atm of HCl and 1.00 atm of O₂ are introduced into a container at 750 K. After equilibrium is established the partial pressure of Cl₂ is found to be 0.93 atm. Calculate K_p for the reaction.

$$\begin{aligned} P_{\text{HCl}} &= 0.44 \text{ atm} & P_{\text{Cl}_2} &= 0.93 \text{ atm} & P_{\text{O}_2} &= 0.53 \text{ atm} & P_{\text{H}_2\text{O}} &= 0.93 \text{ atm} \\ & & & & K_{\text{p}} &= 37.7 \end{aligned}$$

(12) 4. The following exothermic reaction is at equilibrium



Predict what happens to the amount of SO_3 when each of the following changes is made. Provide a brief explanation for your prediction.

a) The temperature is raised.

$[\text{SO}_3]$ decreases..rxn exothermic, so raising the temperature is equivalent to adding heat to the products side of the reaction, the reaction will proceed from R to L to reduce the amount of heat added.

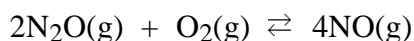
b) More O_2 is added.

$[\text{SO}_3]$ increases..adding will mean Q will be less than K. To re-establish equilibrium the products must increase and the reactants decrease so the reaction proceeds L to R.

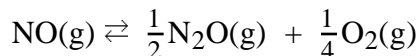
c) The volume of the container is increased.

$[\text{SO}_3]$ decrease..increasing the volume will cause Q will be greater than K. To re-establish equilibrium the products must decrease and the reactants increase so the reaction proceeds R to L.

(4) 5. K_c for the reaction



is 3.39×10^{-8} at 1000 K. Calculate K'_c for the reaction



$$K = \frac{1}{K_c^{1/4}} \frac{1}{(3.39 \times 10^{-8})^{1/4}} 73.7$$

(36) 6. Calculate the pH for each of the following solutions.

a) 0.450 M HCN

$$\text{pH} = 4.82$$

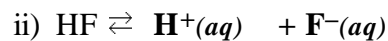
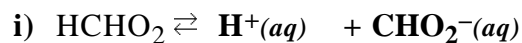
b) 0.210 M $\text{C}_5\text{H}_5\text{N}$

$$\text{pH} = 9.27$$

c) 0.840 M $\text{C}_6\text{H}_5\text{NH}_3\text{NO}_3$

$$\text{pH} = 2.35$$

(22)7a. Write a chemical equation to describe how each of the following behave as acids when dissolved in water. (4)



a) Given solutions of the same concentration which acid in part a) is the strongest? Support your answer with a short explanation. (4)

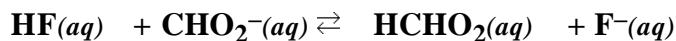
$$K(\text{HF}) = 7.2 \times 10^{-4}$$

$$K(\text{HCHO}_2) = 1.8 \times 10^{-4}$$

K is larger for HF so it is the stronger acid.

b) Given solutions of the same concentration which base F^- or CHO_2^- is the strongest? Support your answer with a short explanation. (4)

c) Write a neutralization reaction between the strongest acid from part b) and the strongest base in part c). (4)



d) Does Na_2HPO_4 behave as an acid or base when added to water? Explain. (6)

Periodic Table of the Elements

	IA																VIII A	
1	1 H 1.008																	2 He 4.00
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	
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 (261)	105 (262)	106 (263)												

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
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)

Actinides

Useful Information

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

$$\text{pH} + \text{pOH} = 14$$

$$\text{pOH} = -\log [\text{OH}^-]$$

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

$$\Delta G^\circ = -RT \ln K$$

$$K_p = K_c (\text{RT})^{\Delta n}$$

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

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}	Pyridine	$\text{C}_5\text{H}_5\text{N}$	1.7×10^{-9}
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