CHEM 1515.002
Exam II
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March 4, 1998

Name _____

TA's Name _____

Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last three pages include a periodic table, a table of vapor pressures for water, a solubility table, a table of ionic structures and packing and an activity series. 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, 4, 5, 6 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	TOTAL
SCORES	_____	_____	_____	_____	_____
	(24)	(26)	(34)	(16)	(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.

a) $Na_2S_2O_{8(aq)} + I^-_{(aq)} \rightarrow$

b) iron(III) chloride$_{(aq)}$ + sodium hydroxide$_{(aq)}$ $\rightarrow$

c) ammonium nirate$_{(aq)}$ + sodium sulfate$_{(aq)}$ $\rightarrow$

d) $Mg_{(s)} + Au^{3+}_{(aq)} \rightarrow$

(6) 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. Describe how you would prepare 250.00 mLs of an aqueous solution of NaOH which is 0.200 M. (Include any safety information which would be important to the person preparing the solution.)

(26) 4. A solution is prepared containing 8.00 g of trichloroacetic acid, CCl_3COOH, in 92.0 g of water. This solution is also 0.509 M.

(6) a) calculate the mol fraction of trichloroacetic acid in the solution.

(6) b) calculate the freezing point of the solution (assuming the CCl_3COOH does not dissociate into ions.)

(4) c) the experimental freezing point of this solution is found to be –1.69 ˚C. Is trichloroacetic acid a strong, weak or nonelectrolyte in water? Explain.

(6) d) Identify the chemical specie(s) in an aqueous solution of trichloroacetic acid. (NOTE: you need not include water, just the specie(s) associated with trichloroacetic acid.) Which is/are present in the highest concentration? Explain.

(4) e) Calculate the density of this solution.

(34) 5. The 2nd order rate constant for the gas phase decomposition

$$2NOCl_{(g)} \rightarrow 2NO_{(g)} + Cl_{2(g)}$$

of nitrosyl chloride, NOCl, is 1.18×10^{-2} $M^{-1} \cdot s^{-1}$ at 450 K.

(8) a) If the initial concentration of NOCl is 0.500 M calculate the concentration of NOCl after 56.5 seconds.

(4) b) What is the fraction of the original NOCl is remaining?

(6) c) How long will it take for the concentration of NOCl to fall to one-half its initial value (as given in a)?

(8) d) If the activation energy, E_a, for the decomposition reaction is 102 $kJ \cdot mol^{-1}$, calculate the rate constant for the reaction at 600 K.

(4) e) Suggest a reaction mechanism for the decomposition reaction.

(4) f) Draw the activated complex for the slow step in your reaction mechanism (be sure to label where bond breaking and forming are occuring).

(8) 6. Camphor, $C_{10}H_{16}O$, is frequently used to determine the molar mass of organic compounds using freezing point depression data because of its large freezing point constant, 37.7 $m \cdot {}^{\circ}C^{-1}$. An unknown organic compound of mass 0.840 g lowered the freezing point of 25.0 g of camphor by 7.6 ˚C. What is the molar mass of the organic compound?

(8) 7. The reaction

$$PCl_{5(g)} \rightleftarrows PCl_{3(g)} + Cl_{2(g)}$$

was studied at 760 ˚C. 0.200 mol of PCl_5 are placed in a 1.00 liter container and allowed to decompose. After equilibrium was established the concentration of PCl_3 was found to be 0.195 M. Calculate the equilibrium constant for the reaction at this temperature.

Periodic Table of the Elements

	IA												IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008	IIA																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	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	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 **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

$PV = nRT$ $\qquad R = 0.0821 \frac{L \cdot atm}{mol \cdot K} = 8.314 \frac{J}{mol \cdot K}$

$P_{solution} = \chi_{solvent} P^{\circ}_{solvent}$ $\qquad$ density of $H_2O = 1.00 \frac{g}{cm^3}$

$\Delta T = ikm$ $\qquad k_f(H_2O) = 1.86 \frac{^{\circ}C}{m}$ $\qquad k_b(H_2O) = 0.512 \frac{^{\circ}C}{m}$

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{[A]_t}{[A]_o}\right) = -kt \qquad \frac{1}{[A]_t} - \frac{1}{[A]_o} = kt$$

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

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

Temperature (°C)	Vapor Pressure(mmHg)	Temperature (°C)	Vapor Pressure(mmHg)
-5	3.2	50	92.5
0	4.6	55	118.0
5	6.52	60	149.4
10	9.20	65	187.5
15	12.8	70	233.7
20	17.5	75	289.1
25	23.8	80	355.1
30	31.8	85	433.6
35	42.1	90	525.8
40	55.3	95	633.9
45	71.9	100	760

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

Metal	Half-Reaction Reaction
Lithium	$Li \rightarrow Li^+ + e^-$
Potassium	$K \rightarrow K^+ + e^-$
Barium	$Ba \rightarrow Ba^{2+} + 2e^-$
Calcium	$Ca \rightarrow Ca^{2+} + 2e^-$
Sodium	$Na \rightarrow Na^+ + e^-$
Magnesium	$Mg \rightarrow Mg^{2+} + 2e^-$
Aluminum	$Al \rightarrow Al^{3+} + 3e^-$
Manganese	$Mn \rightarrow Mn^{2+} + 2e^-$
Zinc	$Zn \rightarrow Zn^{2+} + 2e^-$
Chromium	$Cr \rightarrow Cr^{3+} + 3e^-$
Iron	$Fe \rightarrow Fe^{2+} + 2e^-$
Cobalt	$Co \rightarrow Co^{2+} + 2e^-$
Nickel	$Ni \rightarrow Ni^{2+} + 2e^-$
Tin	$Sn \rightarrow Sn^{2+} + 2e^-$
Lead	$Pb \rightarrow Pb^{2+} + 2e^-$
Hydrogen	$H_2 \rightarrow 2H^+ + 2e^-$
Copper	$Cu \rightarrow Cu^{2+} + 2e^-$
Silver	$Ag \rightarrow Ag^+ + e^-$
Mercury	$Hg \rightarrow Hg^{2+} + 2e^-$
Platinum	$Pt \rightarrow Pt^{2+} + 2e^-$
Gold	$Au \rightarrow Au^{3+} + 3e^-$