CHEM 1314.05
Exam II
John II. Gelder
October 18, 1994

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, a solubility table, a table of enthalpy's of formation and some useful equations. All work should be done in this booklet.

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

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 – 9.

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	____	____	____	____	____	____
	(31)	(20)	(22)	(12)	(15)	(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.

a) $KOH_{(aq)}$ + $H_2SO_{4(aq)}$ $\rightarrow$

b) $Ba(OH)_2 \cdot 8H_2O_{(s)}$ + $NH_4Cl_{(s)}$ $\rightarrow$

c) $Na_2CO_{3(aq)}$ + $HCl_{(aq)}$ $\rightarrow$

(12) 2. Identify the species and/or ions formed when each of the compounds below are added to water by writing the chemical equation which describes what occurs. Also indicate whether the compound is a strong, weak or nonelectrolyte. If the compound does not dissolve write WND (will not dissolve).

	Type of Electrolyte
a) $HNO_{3(l)} \xrightarrow{H_2O}$	________________
b) $MgCl_{2(s)} \xrightarrow{H_2O}$	________________
c) $NH_{3(g)} \xrightarrow{H_2O}$	________________
d) $C_6H_{12}O_{6(s)} \xrightarrow{H_2O}$	________________

(10) 3. The following equation shows a reaction for the preparation of elemental phosphorus, P_4.

$$4Ca(PO_4)_3F + 18SiO_2 + 30C \rightarrow 3P_4 + 2CaF_2 + 18CaSiO_3 + 30CO$$

What mass of SiO_2 is required to completely react with 602 grams of $Ca(PO_4)_3F$?

(10) 4. Aspirin, $C_6H_4(CO_2H)(CO_2CH_3)$, is prepared by by reacting salicylic acid, $C_6H_4(CO_2H)(OH)$, with acetic anhydride, $(CH_3CO)_2O$. The reaction is,

$$2C_6H_4(CO_2H)(OH) + (CH_3CO)_2O \rightarrow 2C_6H_4(CO_2H)(CO_2CH_3) + H_2O$$

What is the maximum number of grams of aspirin which can be obtained when 75.0 g of salicylic acid is reacted with 35.0 g of acetic anhydride?

(10) 5. Calculate the volume of 1.50 M HCl which will completely react with 32.0 grams of $CaCO_3$. The equation which describes the reaction is,

$$CaCO_3(s) + 2HCl(aq) \rightarrow Ca^{2+}(aq) + 2Cl^{-}(aq) + CO_2(g) + H_2O(l)$$

(10) 6. Using the following standard enthalpy of reaction data and Hess' Law determine the enthalpy of formation for $N_2O_5(g)$.

Reaction	ΔH°
$N_2(g) + 3O_2(g) + H_2(g) \rightarrow 2HNO_3(aq)$	–207 kJ
$N_2O_5(g) + H_2O(l) \rightarrow 2HNO_3(aq)$	218 kJ
$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	–286 kJ

Clearly demonstrate how the given equations are to be manipulated to obtain the final equation.

(12) 7a. Disposable lighters use butane as their fuel. Calculate the enthalpy for the combustion of butane as described in the following reaction.

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

b) How much heat is released when 0.0500 grams of $C_4H_{10}(g)$ are combusted in excess oxygen?

(8) 8. The heat of combustion ($\Delta H^\circ_{combustion}$) of benzene, $C_6H_6(l)$, is $-3268\ \frac{kJ}{mol}$. If 1.00 g of benzene is combusted and the heat produced from the combustion is absorbed by 100. g of water initially at 20.0 ˚C, calculate the final temperature of water. Assume no heat is absorbed by the container or the surrounding. (Note: You may wish to provide a brief statement supporting your conclusion.)

(4) 9. Describe how you would prepare exactly 250.0 mLs of a 6.00 molar solution of sodium hydroxide.

Multiple Choice: (15 points)

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

10. ________ 11. ________ 12. ________ 13. ________ 14. ________

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

10. A form of lead oxide reacts with nitric acid according to the following equation

$$Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$$

When 5.25 grams of Pb_3O_4 reacts with 200. mLs of 1.00 M HNO_3, 3.19 gram of $Pb(NO_3)_2$ are recovered. What is the percent yield of the lead (II) nitrate?

A) 39.8% B) 62.9% C) 96.6% D) 100%

11. 100. mLs of 0.500 M HCl are mixed with 50.0 mLs of 0.350 M NaOH. Which of the following statements is true?

A) The final concentration of unreacted NaOH is 0.217 M.
B) The final concentration of Cl^- is 0.500 M.
C) The final concentration of Na^+ is 0.117 M.
D) The final concentration of H^+ is 0.0325 M.

12. The percent composition of a hydrated compound containing Na, S, O and water is,

Component	Percent
Na	14.27
S	9.951
O	19.86
H_2O	55.92

The empirical formula of the hydrate is

A) $Na_2SO_4 \cdot 10H_2O$
B) $Na_2SO_3 \cdot 5H_2O$
C) $Na_2S_2O_3 \cdot 9H_2O$
D) $Na_2S_2O_3 \cdot 5H_2O$

13. Which of the following reactions would you expect to be endothermic?

A) $2Na(s) + 2H_2O(l) \rightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$
B) $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$
C) $2NaCl(s) \rightarrow 2Na(s) + Cl_2(g)$
D) $2NaH(s) \rightarrow 2Na(s) + H_2(g)$

14. Which one of the following samples would require the least amount of thermal energy (heat) to bring its temperature to 80 ˚C?

A) 200 g $H_2O(l)$ at 40 ˚C
B) 100 g $H_2O(l)$ at 20 ˚C
C) 200 g $H_2O(l)$ at 20 ˚C
D) 100 g $H_2O(l)$ at 40 ˚C

Periodic Table of the Elements

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

Specific heat of $H_2O(s)$ = $2.09\ \frac{J}{g\cdot{}^\circ C}$

Specific heat of $H_2O(l)$ = $4.184\ \frac{J}{g\cdot{}^\circ C}$

Specific heat of $H_2O(g)$ = $1.84\ \frac{J}{g\cdot{}^\circ C}$

Heat of fusion of $H_2O(s)$ = $6.01\ \frac{kJ}{mol}$

Heat of vaporization of $H_2O(l)$ = $40.67\ \frac{kJ}{mol}$

$R = 0.08203\ \frac{L\cdot atm}{mol\cdot K}$ or $R = 8.314\ \frac{J}{mol\cdot K}$

q(heat flow) = mass · specific heat · ΔT

$q_{reaction} = -(q_{calorimeter} + q_{solution})$

$q_{reaction} = -(q_{calorimeter} + q_{water})$

$\Delta H^\circ_{rxn} = \Sigma\, n\Delta H^\circ_f\,(\text{products}) - \Sigma\, m\Delta H^\circ_f\,(\text{reactants})$

$\Delta H = \Delta E + \Delta nRT$

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

Table of Standard Heats of Formation

Substance and State	ΔH°_f (kJ/mol)	Substance and State	ΔH°_f (kJ/mol)
C(*s*) (graphite)	0	$HCl(g)$	-92.3
C(*s*) (diamond)	2	$HBr(g)$	-36.4
$CO(g)$	-110.5	$HI(g)$	26.5
$CO_2(g)$	–393.5	$I_2(g)$	62.25
$CH_4(g)$	–75	$O_2(g)$	0
$CH_3OH(g)$	-201	$O(g)$	249
$CH_3OH(l)$	-239	$O_3(g)$	143
$H_2CO(g)$	-116		
$CCl_4(l)$	-135.4	$N_2(g)$	0
$HCOOH(g)$	-363	$NH_3(g)$	-46
$HCN(g)$	135.1	$NH_3(aq)$	-80
$CS_2(g)$	117.4	$NH_4^+(aq)$	-132
$CS_2(l)$	89.7	$N_2H_3CH_3(l)$	54
$C_2H_2(g)$	227	$N_2H_4(l)$	50.6
$C_2H_4(g)$	52	$NO(g)$	90.25
$CH_3CHO(g)$	-166	$NO_2(g)$	33.18
$C_2H_5OH(l)$	-278	$N_2O(g)$	82.0
$C_2H_5O_2N(g)$	-533	$N_2O_4(g)$	9.16
$C_2H_6(g)$	-84.7	$N_2O_4(l)$	20
$C_3H_6(g)$	20.9	$HNO_3(aq)$	-207.36
$C_3H_8(g)$	-104	$HNO_3(l)$	-174.10
$C_4H_{10}(g)$	-126	$NH_4ClO_4(s)$	-295
$CH_2 = CHCN(l)$	152		
$CH_3COOH(l)$	-484		
$C_6H_{12}O_6(s)$	-1275	$SO_2(g)$	-296.83
$TiO_2(s)$	-945	$H_2S(g)$	-20.6
$Cl_2(g)$	0	$SOCl_2(g)$	-213
$Cl_2(aq)$	-23	$S_2Cl_2(g)$	-18
$Cl^-(aq)$	-167		
		$SiO_2(s)$	-910.94
		$SiF_4(g)$	-1614.9
$H_2(g)$	0	$SiCl_4(g)$	-657
$H(g)$	217		
$H^+(aq)$	0	$TiCl_4(g)$	-763
$OH^-(aq)$	-230	$TiO_2(s)$	-944.7
$H_2O(l)$	-286		
$H_2O(g)$	-242		