CHEM 1314.03
Exam II
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October 23, 1997
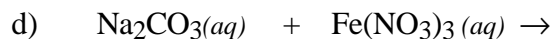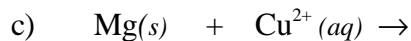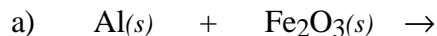
Name _____

TA's Name _____

Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last four pages include a periodic table, a solubility table, a table of enthalpy's of formation, an activity series 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 problems 3 – 8.

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	_____	_____	_____	_____		_____
	(34)	(25)	(21)	(20)		(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. If no reaction occurs write NR.

   a) $Al_{(s)}$ + $Fe_2O_{3(s)}$ →

   b) $Na_2SO_{4\ (aq)}$ + $NH_4Cl_{(aq)}$ →

   c) $Mg_{(s)}$ + $Cu^{2+}_{(aq)}$ →

   d) $Na_2CO_{3(aq)}$ + $Fe(NO_3)_{3\ (aq)}$ →

(12) 2. Write the ionic and net ionic chemical equations for 1b) and 1d).

   1b)
          Ionic equation:
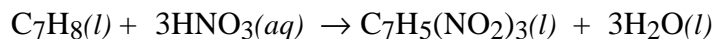

          Net Ionic equation:

   1d)
          Ionic equation:

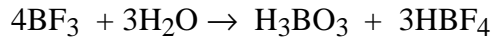   Net Ionic equation:

(10) 3. An explosive, trinitrotoluene, is prepared by reacting toluene with nitric acid according to the equation

$$C_7H_{8(l)} +\ 3HNO_{3(aq)}\ →\ C_7H_5(NO_2)_{3(l)}\ +\ 3H_2O_{(l)}$$

What mass of toluene and nitric acid are required to produce 50.0 g of trinitrotoluene?

(15) 4. Boric acid is formed in the reaction between boron trifluoride and water. The reaction is,

$$4BF_3 + 3H_2O \rightarrow H_3BO_3 + 3HBF_4$$

What is the maximum number of grams of boric acid which can be obtained when 150. g of boron trifluoride is reacted with 35.0 g of water?

Calculate the final mass of both reactants after the reaction has gone to completion.

(10) 5. Calculate the mass of oxalic acid that reacts with 0.680 mLs of 2.44 x 10^{-3} M $KMnO_4$ in excess sulfuric acid. The equation which describes the reaction between oxalic acid, potassium permanganate and sulfuric acid is,

$$2KMnO_{4(aq)} + 5H_2C_2O_{4(aq)} + 3H_2SO_{4(aq)} \rightarrow K_2SO_{4\ (aq)} + 2MnSO_{4(aq)} + 10CO_{2(g)} + 8H_2O_{(l)}$$
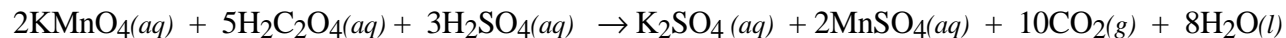
(9) 6. The industrial preparation of nitric acid, the Ostwald Process, converts ammonia to nitric acid. Using the following standard enthalpy of reaction data and Hess' Law determine the enthalpy for production of nitric acid from ammonia. (Note: While ammonia and nitric acid are the only two substances mentioned it should be realized other substances may be needed to obtain a balanced chemical equation which describes the conversion of ammonia to nitric acid.)

<div align="center">

Reaction $\Delta H°$

$4NH_{3(g)} + 5O_{2(g)} \rightarrow 4NO_{(g)} + 6H_2O_{(g)}$ –907 kJ

$2NO_{(g)} + O_{2(gl)} \rightarrow 2NO_{2(g)}$ –114 kJ

$3NO_{2(g)} + H_2O_{(g)} \rightarrow 2HNO_{3(aq)} + NO_{(g)}$ –182 kJ

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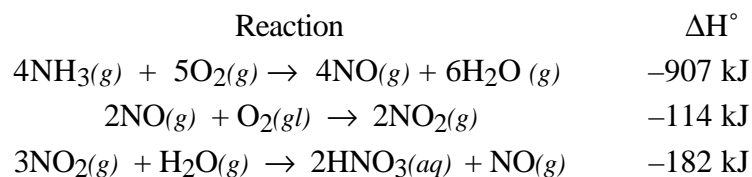
Clearly demonstrate how the given equations are to be manipulated to obtain the final equation.

(12) 7a. When a sulfide is combusted sulfur dioxide is a product. Calculate $\Delta H°_{rxn}$ for the combustion of zinc sulfide.

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$2ZnS_{(s)} + 3O_{2(g)} \rightarrow 2ZnO_{(s)} + 2SO_{2(g)}$

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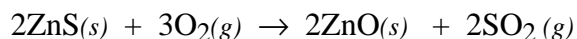
(20) 8a.   45.0 g of water at 33.0 ˚C are added to 24.0 g of water, in a calorimeter, at 21.0 ˚C. The final
temperature of the mixture is 27.8 ˚C. Calculate the heat capacity of the calorimeter.

b.   1.980 g of KOH are added to the same calorimeter used in the experiment in part a) above which now
holds 50.0 mLs of water. The initial temperature of the water in the calorimeter 22.6 ˚C. If the final
temperature of the solution in the calorimeter after adding the KOH is 31.2 ˚C, calculate the molar heat of
solution for KOH. (Assume the specific heat of the solution is equal to the specific heat of pure water.)

Periodic Table of the Elements

IA																	VIIIA
1 **H** 1.008	IIA											IIIA	IVA	VA	VIA	VIIA	2 **He** 4.00
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
11 **Na** 22.99	12 **Mg** 24.30	IIIB	IVB	VB	VIB	VIIB	⎯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
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
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
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)
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

Specific heat of $H_2O_{(s)} = 2.09 \frac{J}{g \cdot °C}$

Specific heat of $H_2O_{(l)} = 4.184 \frac{J}{g \cdot °C}$

Specific heat of $H_2O_{(g)} = 1.84 \frac{J}{g \cdot °C}$

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

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

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

$\Delta H°_{rxn} = \Sigma\, n\Delta H°_f \text{ (products)} - \Sigma\, m\Delta H°_f \text{ (reactants)}$

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

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	S_2Cl_2(g)	-18
$C_6H_{12}O_6$(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		
Cl^-(aq)	-167	$SiCl_4$(g)	-657
		SiO_2(s)	-910.94
		SiF_4(g)	-1614.9
H_2(g)	0		
H(g)	217	TiO_2(s)	-944.7
H^+(aq)	0	$TiCl_4$(g)	-763
OH^-(aq)	-230		
H_2O(l)	-286	ZnO(s)	-348
H_2O(g)	-242	ZnS(s)	-206

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	$Au \rightarrow Au^{3+} + 3e^-$