CHEM 1515.001 - 009
Exam I
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February 5, 2003

Name **ANSWERS**

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 vapor pressures for water, a solubility table and a table of thermodynamic values. 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 4a, 4c, 4e, and 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	_____ (28)	_____ (30)	_____ (20)	_____ (22)	_____ (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) $\mathbf{3}Na_2S_{(aq)} + \mathbf{2}Al(NO_3)_{3(aq)} \rightarrow \mathbf{Al_2S_{3(s)}} + \mathbf{6NO_3^-{}_{(aq)}} + \mathbf{6Na^+_{(aq)}}$

b) $K_2CO_{3(aq)} + \mathbf{2}HCl_{(aq)} \rightarrow \mathbf{CO_{2(g)}} + \mathbf{H_2O_{(l)}} + \mathbf{2Cl^-_{(aq)}} + \mathbf{2K^+_{(aq)}}$

c) $\mathbf{3}Zn_{(s)} + \mathbf{2}Cr(NO_3)_{3(aq)} \rightarrow \mathbf{2Cr_{(s)}} + \mathbf{6NO_3^-{}_{(aq)}} + \mathbf{3Zn^{2+}_{(aq)}}$

d) $\mathbf{2}C_7H_{14(l)} + \mathbf{21}O_{2(g)} \rightarrow \mathbf{14CO_{2(g)}} + \mathbf{14H_2O_{(l)}}$

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

Ionic equation

$$\mathbf{6NO_3^-{}_{(aq)} + 6Na^+_{(aq)} + 3S^{2-}_{(aq)} + 2Al^{3+}_{(aq)} \rightarrow Al_2S_{3(s)} + 6NO_3^-{}_{(aq)} + 6Na^+_{(aq)}}$$

Net Ionic equation

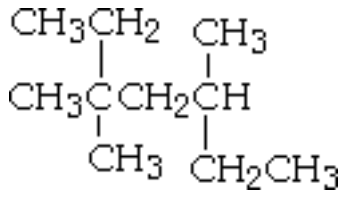
$$\mathbf{3S^{2-}_{(aq)} + 2Al^{3+}_{(aq)} \rightarrow Al_2S_{3(s)}}$$

(12) 3. Identify the intermolecular attractive force(s) present in the liquids of the following substances. If more than one interparticle force, indicate which is the most important.

a) CH_2F_2 **CH_2F_2 is a polar compound, so both dispersion forces and dipole-dipole forces. In this case since all of the elements are in the 2nd period dipole-dipole forces are most likely the stronger force of the two.**	b) CH_3CH_2OH **CH_3CH_2OH is a polar compound, that also contains an O–H functional group. Both dispersion forces and hydrogen-bonding forces are present. Hydrogen-bonding is the stronger force of the two.**
c) PCl_3 **PCl_3 is a polar compound, so both dispersion forces and dipole-dipole forces. In this case since phosphorus is in the third period dispersion forces are the stronger force of the two.**	d) In the space below draw several CH_3CH_2OH molecules and label the intermolecular attraction that occurs between adjacent molecules. **See answer posted on the wall outside my office.**

(40) 4. **See answer posted on the wall outside my office following our HelpSession on Saturday.**

(6) 5. Give the name or draw the complete Lewis structure (showing all C-H(X) bonds) for each of the following compounds.

	3-ethyl-3-methylpentane	1,3-dichloro-1,2,2-trifluoropropane

See answer posted on the wall outside my office following our HelpSession on Saturday.

(4) 6. **See answer posted on the wall outside my office following our HelpSession on Saturday.**

(12) 7. Draw and name six different structural isomers for $C_6H_{12}Cl_2$. (NOTE: You may use condensed formulas when representing the different structural isomers.)

See answer posted on the wall outside my office following our HelpSession on Saturday.

(10) 8. Benzene has a normal boiling point of 80.1 ˚C and a heat of vaporization of 30.8 kJ mol^{-1}. What is the temperature when the vapor pressure of benzene is 450 mmHg?

$$\ln \frac{P_1}{P_2} = \frac{-\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln \frac{450}{760} = \frac{-30800 \frac{J}{mol}}{8.314 \frac{J}{mol \cdot K}}\left(\frac{1}{T_1} - \frac{1}{353.1K}\right)$$

$$\ln (0.592) = -3704.6\left(\frac{1}{T_1} - \frac{1}{353.1}\right)$$

$$-0.524 = -3704.6\left(\frac{1}{T_1} - \frac{1}{353.1}\right)$$

$$1.41 \times 10^{-4} = \left(\frac{1}{T_1} - 2.83 \times 10^{-3}\right)$$

$$\frac{1}{T_1} = 1.41 \times 10^{-4} + 2.83 \times 10^{-3} \qquad T_1 = 322\ K$$

$$\frac{1}{T_1} = 2.97 \times 10^{-3} \qquad T_1 = 336\ K$$

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	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

$PV = nRT$

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

$\ln\left(\frac{vp_2}{vp_1}\right) = -\frac{\Delta H^\circ_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

density of $H_2O = 1.00 \frac{g}{cm^3}$

density of $H_2O = 1.00 \frac{g}{cm^3}$

$\Delta H^\circ_{rxn} = \sum n(\Delta H_f^\circ(\text{products})) - \sum m(\Delta H_f^\circ(\text{reactants}))$

$\Delta S^\circ_{rxn} = \sum n(S^\circ(\text{products})) - \sum m(S^\circ(\text{reactants}))$

$\Delta G^\circ_{rxn} = \sum n(\Delta G_f^\circ(\text{products})) - \sum m(\Delta G_f^\circ(\text{reactants}))$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

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

Thermodynamic Values (25 ˚C)

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Carbon			
C(*s*) (graphite)	0	0	6
C(*s*) (diamond)	2	3	2
CO(*g*)	-110.5	-137	198
$CO_2(g)$	-393.5	-394	214
$CH_4(g)$	?	-51	186
$CH_3OH(g)$	-201	-163	240
$CH_3OH(l)$	-239	-166	127
$CH_3Cl(g)$	-80.8	-57.4	234
$CHCl_3(g)$	-100.8		
$CHCl_3(l)$	-131.8		
$H_2CO(g)$	-116	-110	219
HCOOH(*g*)	-363	-351	249
HCN(*g*)	135.1	125	202
$C_2H_2(g)$	227	209	201
$C_2H_4(g)$	52	68	219
$CH_3CHO(g)$	-166	-129	250
$C_2H_5OH(l)$	-278	-175	161
$C_2H_6(g)$	-84.7	-32.9	229.5
$C_3H_6(g)$	20.9	62.7	266.9
$C_3H_8(g)$	-104	-24	270
Bromine			
$Br_2(l)$	0	0	152.
BrCl(*g*)	14.64	-0.96	240
Chlorine			
$Cl_2(g)$	0	0	223
$Cl_2(aq)$	-23	7	121
$Cl^-(aq)$	-167	-131	57
HCl(*g*)	-92	-95	187
Fluorine			
$F_2(g)$	0	0	203
$F^-(aq)$	-333	-279	-14
HF(*g*)	-271	-273	174
Hydrogen			
$H_2(g)$	0	0	131
H(*g*)217	203	115	
$H^+(aq)$	0	0	0
$OH^-(aq)$	-230	-157	-11
$H_2O(l)$			
$H_2O(g)$	-242	-229	189
Magnesium			
Mg(s)	0	0	33
Mg(aq)	-492	-456	-118
MgO(s)	-601	-569	26.9

Substance and State	ΔH^o_f $\left(\frac{kJ}{mol}\right)$	ΔG^o_f $\left(\frac{kJ}{mol}\right)$	S^o $\left(\frac{J}{K \cdot mol}\right)$
Oxygen			
$O_2(g)$	0	0	205
O(*g*)249	232	161	
$O_3(g)$	143	163	239
Nitrogen			
$N_2(g)$	0	0	192
$NCl_3(g)$	230	271	-137
$NF_3(g)$	-125	-83.6	-139
$NH_3(g)$	?	-17	193
$NH_3(aq)$	?	-27	111
NH_2CONH_2(aq)	?	?	174
NO(*g*)	90	87	211
$NO_2(g)$	32	52	240
$N_2O(g)$	82	104	220
$N_2O_4(g)$	10	98	304
$N_2O_5(g)$	-42	134	178
$HNO_3(aq)$	-207	-111	146
$HNO_3(l)$	-174	-81	156
NH_4Cl(s)	-314	-201	95
NH_4ClO_4(s)	-295	-89	186
Silver			
Ag(*s*)	0	0	42.6
$Ag^+(aq)$	105.6	77.1	72.7
$Ag(S_2O_3)^{3-}(aq)$	-1285.7	--	--
AgBr(s)	-100.4	-96.9	107.1
AgCl(s)	-127.1	-109.8	96.2
Sulfur			
S(rhombic)	0	0	31.8
SO_2(g)	-296.8	-300.2	248.8
SO_3(g)	-395.7	-371.1	256.3
H_2S(g)	-20.17	-33.0	205.6
Phosphorus			
$P_4(s)$	0	0	41.1
$PCl_5(g)$	-375	-305	365
Aluminum			
$AlCl_3(s)$	-526	-505	184
Barium			
$BaCl_2(aq)$	-872	-823	123
$Ba(OH)_2 \cdot 8H_2O(s)$	-3342	-2793	427
Iodine			
$I_2(s)$	0	0	116.7
HI(*g*)	25.94	1.30	206.3

Activity Series

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

$\xrightarrow{H_2O}$