CHEM 1515.002
Exam I
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February 4, 1998

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 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 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	_____	_____	_____	_____	_____
	(26)	(18)	(32)	(24)	(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) $Mg(OH)_{2(s)} + HCl_{(aq)} \rightarrow$

b) $(NH_4)_2CO_{3(aq)} + Cu(NO_3)_{2(aq)} \rightarrow$

c) $Pb(NO_3)_{2(aq)} + KBr_{(aq)} \rightarrow$

d) hydrochloric acid$_{(aq)} + Mg_{(s)} \rightarrow$

(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:

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

a) SCl_2

b) NH_4Cl

c) CH_3OH

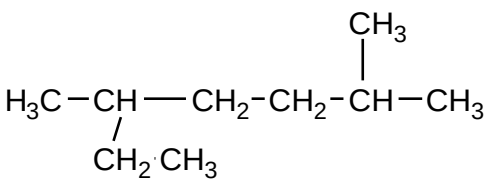
d) $C_{diamond}$

(12) 4. In each of the following groups, pick the member which has the given property. Provide a brief explanation for our choice. Be sure explanation explains why the other two choices were ruled out.

a) highest boiling point; CH_4, CCl_4, CF_4

b) lowest vapor pressure at 25 ˚C; CH_3CH_2OH, $CH_3CH_2CH_3$, CH_3OCH_3

(6) 5. Give the name or draw the Lewis structure for each of the following compounds.

3-ethyl-1-pentyne	trans-3, 5-dimethyl-2-hexene	

(14) 6. Draw ALL of the structural isomers for C_4H_7Cl. Name at least four of these isomers.

(18) 7. The metal hydride, LiH has a density of 0.77 $g \cdot cm^{-3}$. The length of the cubic unit cell edge is 4.086 Å. Assume the H^- anion(s) defines the packing in the structure and the cation(s) are in the hole(s).

a) Calculate the volume of the unit cell.

b) Calculate the mass of the unit cell.

c) Identify the most likely type of packing of the anion; and for the cation the type hole and its occupancy. Briefly explain or provide supporting calculations to justify your answer(s). Note: if there is more than one possiblity for the packing of the anion or hole type for the cation list each type and indicate the additional data needed to choose between the possibilities.

(16) 8a. Acetone has a ΔH°_{vap} of 32.4 kJ·mol^{-1} and a normal boiling point of 56 ˚C. Calculate the (equilibrium) vapor pressure of acetone at 23 ˚C (room temperature).

b) A 1.00 gram sample of acetone is placed into an evacuated 1.00 L container at 56.0 ˚C. The container is then cooled to 23.0 ˚C. Describe the phase(s) present at 23.0 ˚C. (Show your work to justify your answer.)

(8) 9. Choose the member of each set that has the higher solubility in water. Briefly, explain your answer.
a) $CH_3CH_2CH_3$ or CH_3OCH_3

b) Carbon dioxide or silicon dioxide

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			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

$PV = nRT$

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

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

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

edge length (l) = 2r

edge length (l) = $2\sqrt{2} \cdot$ r

edge length (l) = $\frac{4r}{\sqrt{3}}$

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

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

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

Simple Ionic Structures Grouped According to Anion Packing

Structure Name	Anion Packing	Coordination Number	Sites Occupied by Cations	Examples
Rock Salt	ccp	6:6 MO	all octahedral	NaCl, LiF, KBr, CdO, FeO, MgO
Zinc Blende	ccp	4:4 MO	$\frac{1}{2}$ tetrahedral	ZnS, BeO, SiC
Antifluorite	ccp	4:8 M_2O	all tetrahedral	Li_2O, sulfides
Rutile	distorted ccp	6:3 MO_2	$\frac{1}{2}$ octahedral	TiO_2, GeO_2, MnO_2, OsO_2
Perovskite	ccp	12:6:6 ABO_3	$\frac{1}{4}$ octahedral(B)	$CaTiO_3$, $SrSnO_3$
Spinel	ccp	4:6:4 AB_2O_4	$\frac{1}{8}$ tetrahedral(A) $\frac{1}{2}$ octahedral(B)	$MgAl_2O_4$, $FeAlO_4$
Cesium Chloride	simple cubic	8:8 MO	all cubic	CsCl, CsBr, CsI
Florite	simple cubic	8:4 MO_2	$\frac{1}{2}$ cubic	CaF_2, UO_2, ThO_2

Lattice Types and Radius Ratios of Cations and Anions

Radius Ratio (Cation/Anion)	Lattice Type	Coordination Number of Cation	Coordination Number of Anion
A. 1:1 Stoichiometry of Salt (MX)			
0.225 – 0.414	Zinc Blende	4	4
0.414 – 0.732	Rock salt (NaCl)	6	6
0.732 – 1.000	Cesium chloride	8	8
B. 1:2 Stoichiometry of Salt (MX_2)			
0.225 – 0.414	Beta-quartz	4	2
0.414 – 0.732	Rutile (TiO_2)	6	3
0.732 – 1.000	Fluorite (CaF_2)	8	4

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