

CHEM 1515.002
Exam I
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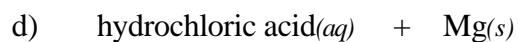
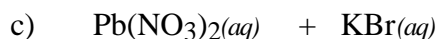
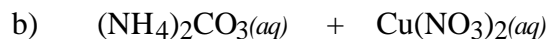
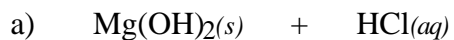
Name _____
TA's Name _____
Lab Section _____

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	<u> </u> (26)	<u> </u> (18)	<u> </u> (32)	<u> </u> (24)	<u> </u> (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.



(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.



(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 ; $\text{CH}_3\text{CH}_2\text{OH}$, $\text{CH}_3\text{CH}_2\text{CH}_3$, 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	$\begin{array}{ccccccc} & & & & \text{CH}_3 & & \\ & & & & & & \\ \text{H}_3\text{C} & -\text{CH} & -\text{CH}_2 & -\text{CH}_2 & -\text{CH} & -\text{CH}_3 \\ & / & & & & & \\ & \text{CH}_2\text{CH}_3 & & & & & \end{array}$
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- (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 $0.77 \text{ g}\cdot\text{cm}^{-3}$. The length of the cubic unit cell edge is 4.086 \AA . Assume the H⁻ anion(s) defines the packing in the structure and the cation(s) are in the hole(s).
- Calculate the volume of the unit cell.
 - Calculate the mass of the unit cell.
 - 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 possibility 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 H_{vap}° of $32.4 \text{ kJ}\cdot\text{mol}^{-1}$ 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) $\text{CH}_3\text{CH}_2\text{CH}_3$ or CH_3OCH_3

b) Carbon dioxide or silicon dioxide

Periodic Table of the Elements

	IA																VIII A	
1	1 H 1.008																	2 He 4.00
		IIA										IIIA	IVA	VA	VIA	VIIA		
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	
			IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB						
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

$$PV = nRT$$

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

$$\ln \frac{vp_2}{vp_1} = -\frac{H_{\text{vap}}^{\circ}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\text{density of H}_2\text{O} = 1.00 \frac{\text{g}}{\text{cm}^3}$$

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

$$\text{edge length (l)} = 2\sqrt{2} \cdot r \quad \text{edge length (l)} = \frac{4r}{\sqrt{3}}$$

$$\text{density of H}_2\text{O} = 1.00 \frac{\text{g}}{\text{cm}^3}$$

$$H_{\text{rxn}}^{\circ} = (H_f^{\circ}(\text{products})) - (H_f^{\circ}(\text{reactants}))$$

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

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
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 ₂ O	all tetrahedral	Li ₂ O, 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 ₂ O ₄	$\frac{1}{8}$ tetrahedral(A) $\frac{1}{2}$ octahedral(B)	MgAl ₂ O ₄ , FeAlO ₄
Cesium Chloride	simple cubic	8:8 MO	all cubic	CsCl, CsBr, CsI
Fluorite	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
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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 (MX₂)

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