

CHEM 1515.001 - 009  
Exam II  
John II. Gelder  
March 5, 2003

Name \_\_\_\_\_

TA's Name \_\_\_\_\_

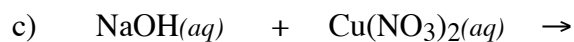
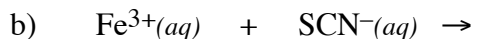
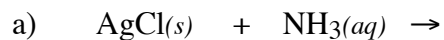
Section \_\_\_\_\_

### INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last four pages include a periodic table; useful mathematical equations and constants; a table of vapor pressures for water; a solubility table; 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 6b - 6d, 6f, 7a and 7b.
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	_____	_____	_____	_____	_____	_____
	(21)	(20)	(32)	(15)	(12)	(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. Soluble ionic compounds should be written in the form of their component ions.



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

Ionic equation

Net Ionic equation

(8) 3. For the following four substances



predict the order of the melting points from highest to lowest.

Highest Lowest

\_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_ > \_\_\_\_\_

Explain, your order in terms of the types of attractive forces that occur in each solid.

(12) 4. Given the three substances

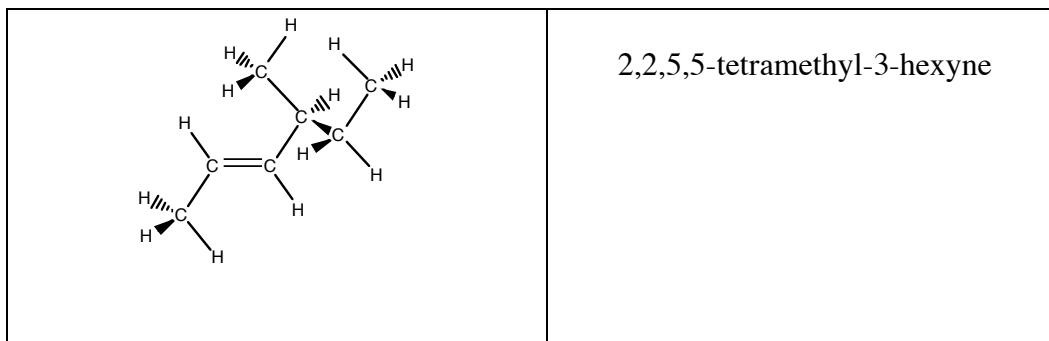


a) Which substance is the most soluble in water? Explain.

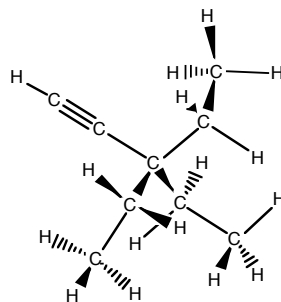
b) Which substance is the least soluble in water? Explain.

c) For the remaining substance, identify a solvent it will dissolve. Explain why you selected the particular solvent.

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



*cis*-4-methyl-2-hexene



(47) 6a. When the ionic solid  $(\text{NH}_4)_2\text{SO}_4$  dissolves in water the temperature of the solution decreases. In terms of the steps of the solution process explain why  $(\text{NH}_4)_2\text{SO}_4$  dissolving in water is endothermic. (8)

b) You are responsible for preparing 250.00 mLs of a 0.450 M  $(\text{NH}_4)_2\text{SO}_4$  solution using pure  $(\text{NH}_4)_2\text{SO}_4$ , distilled water and any equipment you require. Explain how you would prepare this solution. (show important calculations) (8)

c) The density of the solution in b) is  $1.036 \text{ g cm}^{-3}$ . Calculate the weight percent of the solute in the solution. (6)

d) Calculate the ideal freezing point of the solution in b). (10)

## 6.(CONTINUED)

- e) A student carefully determines the experimental freezing point of this solution. She finds the freezing point is  $-2.02\text{ }^{\circ}\text{C}$ . How would you explain the difference between the experimental and the ideal freezing point of this solution? (6)

f) You are given a compound with the formula  $\text{CH}_4\text{N}_2$ . The experimental freezing point of a solution prepared by dissolving 4.40 g of  $\text{CH}_4\text{N}_2$  in 100. grams of water was found to be  $-0.26\text{ }^{\circ}\text{C}$ . (9)

i) Is the compound ionic or covalent? Explain.

ii) Re-write the formula to reflect the type of compound you indicated in i).

(12) 7. An unknown metal has a density of  $10.5 \text{ g cm}^{-3}$ . The metal crystallizes in a face-centered cubic unit cell system. The edge length of the cubic unit cell is  $4.07 \text{ \AA}$ .

a) Determine the molar mass of the unknown metal. (7)

b) Determine the atomic radius of the unknown metal. (4)

c) What is the name and/or symbol for the unknown metal. (1)

Periodic Table of the Elements

	IA																VIII A	
1	1 <b>H</b> 1.008	IIA										IIIA	IVA	VA	VIA	VIIA	2 <b>He</b> 4.00	
2	3 <b>Li</b> 6.94	4 <b>Be</b> 9.01										5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18	
3	11 <b>Na</b> 22.99	12 <b>Mg</b> 24.30	IIIB	IVB	VB	VIB	VIIB	VIII	IB	IIB	13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.06	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95		
4	19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.38	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
5	37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.1	45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.4	47 <b>Ag</b> 107.9	48 <b>Cd</b> 112.4	49 <b>In</b> 114.8	50 <b>Sn</b> 118.7	51 <b>Sb</b> 121.8	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.3
6	55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.8	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209.0	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
7	87 <b>Fr</b> (223)	88 <b>Ra</b> 226.0	89 <b>Ac</b> 227.0	104 (261)	105 (262)	106 (263)												

Lanthanides	58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.2	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0
Actinides	90 <b>Th</b> 232.0	91 <b>Pa</b> 231.0	92 <b>U</b> 238.0	93 <b>Np</b> 237.0	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)

## Useful Information

$$1 \text{ pm} = 10^{-12} \text{ m}$$

$$R = 0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}} = 8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}} \quad 6.02 \times 10^{23}$$

$$P_{\text{solution}} = \chi_{\text{solvent}} P^{\circ}_{\text{solvent}}$$

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

$$\Delta T = i k m \quad k_f(\text{H}_2\text{O}) = 1.86 \frac{^{\circ}\text{C}}{\text{m}} \quad k_b(\text{H}_2\text{O}) = 0.512 \frac{^{\circ}\text{C}}{\text{m}}$$

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

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

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

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



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

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
NO <sub>3</sub> <sup>-</sup>	soluble	none
ClO <sub>4</sub> <sup>-</sup>	soluble	none
Cl <sup>-</sup>	soluble	except Ag <sup>+</sup> , Hg <sub>2</sub> <sup>2+</sup> , *Pb <sup>2+</sup>
I <sup>-</sup>	soluble	except Ag <sup>+</sup> , Hg <sub>2</sub> <sup>2+</sup> , Pb <sup>2+</sup>
SO <sub>4</sub> <sup>2-</sup>	soluble	except Ca <sup>2+</sup> , Ba <sup>2+</sup> , Sr <sup>2+</sup> , Hg <sup>2+</sup> , Pb <sup>2+</sup> , Ag <sup>+</sup>
CO <sub>3</sub> <sup>2-</sup>	insoluble	except Group IA and NH <sub>4</sub> <sup>+</sup>
PO <sub>4</sub> <sup>3-</sup>	insoluble	except Group IA and NH <sub>4</sub> <sup>+</sup>
-OH	insoluble	except Group IA, *Ca <sup>2+</sup> , Ba <sup>2+</sup> , Sr <sup>2+</sup>
S <sup>2-</sup>	insoluble	except Group IA, IIA and NH <sub>4</sub> <sup>+</sup>
Na <sup>+</sup>	soluble	none
NH <sub>4</sub> <sup>+</sup>	soluble	none
K <sup>+</sup>	soluble	none

\*slightly soluble

## Activity Series

Metal	Half-Reaction Reaction
Gold	$\text{Au}^{3+} + 3\text{e}^{-} \rightarrow \text{Au}$
Platinum	$\text{Pt}^{2+} + 2\text{e}^{-} \rightarrow \text{Pt}$
Mercury	$\text{Hg}^{2+} + 2\text{e}^{-} \rightarrow \text{Hg}$
Silver	$\text{Ag}^{+} + \text{e}^{-} \rightarrow \text{Ag}$
Copper	$\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$
Hydrogen	$2\text{H}^{+} + 2\text{e}^{-} \rightarrow \text{H}_2$
Lead	$\text{Pb}^{2+} + 2\text{e}^{-} \rightarrow \text{Pb}$
Tin	$\text{Sn}^{2+} + 2\text{e}^{-} \rightarrow \text{Sn}$
Nickel	$\text{Ni}^{2+} + 2\text{e}^{-} \rightarrow \text{Ni}$
Cobalt	$\text{Co}^{2+} + 2\text{e}^{-} \rightarrow \text{Co}$
Iron	$\text{Fe}^{2+} + 2\text{e}^{-} \rightarrow \text{Fe}$
Chromium	$\text{Cr}^{3+} + 3\text{e}^{-} \rightarrow \text{Cr}$
Zinc	$\text{Zn}^{2+} + 2\text{e}^{-} \rightarrow \text{Zn}$
Manganese	$\text{Mn}^{2+} + 2\text{e}^{-} \rightarrow \text{Mn}$
Aluminum	$\text{Al}^{3+} + 3\text{e}^{-} \rightarrow \text{Al}$
Magnesium	$\text{Mg}^{2+} + 2\text{e}^{-} \rightarrow \text{Mg}$
Sodium	$\text{Na}^{+} + \text{e}^{-} \rightarrow \text{Na}$
Calcium	$\text{Ca}^{2+} + 2\text{e}^{-} \rightarrow \text{Ca}$
Barium	$\text{Ba}^{2+} + 2\text{e}^{-} \rightarrow \text{Ba}$
Potassium	$\text{K}^{+} + \text{e}^{-} \rightarrow \text{K}$
Lithium	$\text{Li}^{+} + \text{e}^{-} \rightarrow \text{Li}$

