CHEM 1515
Exam I
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September 16, 1993

Name _____

TA's Name _____

Lab Section _____

Please sign your name below to give permission to post, by the last 4 digits of your student I.D. number, your course scores on homework, laboratories and exams. If you do not give me permission by signing I will not post any of your scores.

_____
(signature)

INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last two pages include a periodic table, a table of vapor pressures for water, a solubility table 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 6 - 9.

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	_____ (30)	_____ (24)	_____ (19)	_____ (27)	_____ (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.

a) $Ni(NO_3)_{2(aq)} + NaOH_{(aq)} \rightarrow$

b) $Na_{(s)} + H_2O_{(l)} \rightarrow$

c) $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow$

(3) 2. Describe what happens when 10 drops of aqueous 3 M NH_3 is added to a test tube containing the products of the reaction between $AgNO_{3(aq)}$ and $NaCl_{(aq)}$. Write the chemical equation for the reaction which occurs between one of the products of the reaction and $NH_{3(aq)}$.

(8) 3. Complete the following equations to describe the indicated compound's behavior when added to water. If the compound will not dissolve in water, write WND.

a) $CH_3COOH_{(l)} \xrightarrow{H_2O}$

b) $(NH_4)_2CO_{3(s)} \xrightarrow{H_2O}$

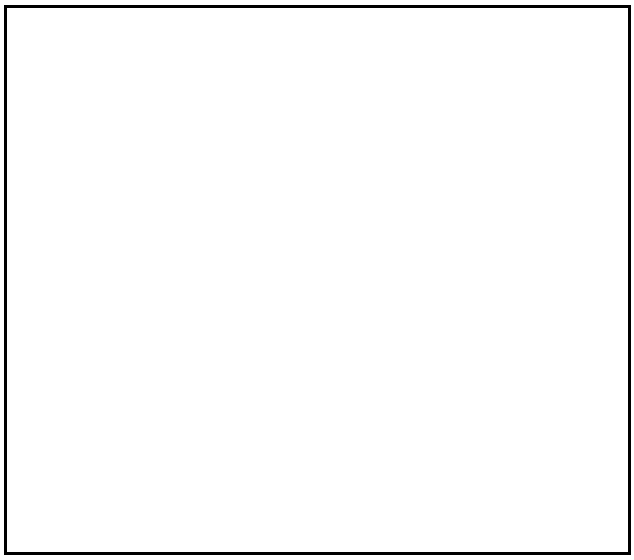
c) $C_{12}H_{22}O_{11(s)} \xrightarrow{H_2O}$

d) $K_3PO_{4(s)} \xrightarrow{H_2O}$

(10) 4. Considering intermolecular attractive forces, briefly explain the following observations. In the boxed section sketch diagram(s), depicting at the atomic level, how $(NH_2)_2CO$ interacts with several water molecules.

a) $(NH_2)_2CO_{(s)}$ dissolves in $H_2O_{(l)}$

b) $NaCl_{(s)}$ does not dissolves in $CCl_{4(l)}$



(6) 5. Indicate the type of attractive force(s) that occur in each of the following pure substances:

a) $(CH_3)_2CO_{(l)}$

b) $CS_{2(l)}$

c) $MgO_{(s)}$

d) $CH_3COOH_{(l)}$

(8) 6. Describe how you would prepare 500. mL of a 0.0300 M NaCl solution beginning with a 0.750 M NaCl solution. You should use any additional volumetric flasks and/or pipets of desired volume in your description of the solution preparation.

(10) 7. A solution of hydrochloric acid in water, $HCl_{(aq)}$, is 38.00% hydrogen chloride, HCl, by weight. Calculate the molality of the solution.

(10) 8a. The mole fraction of glycerol, $C_3H_8O_3$, in a particular glycerol–water solution is equal to 0.115. Determine the mass of glycerol in 300 mLs of this solution if the density of the solution is 1.101 $g \cdot mL^{-1}$.

b. Glycerol is miscible in water. Draw a Lewis structure for glycerol which supports this experimental fact.

(9) 9. Determine the ideal boiling point of a solution prepared by mixing 4.10 g of $Ca(NO_3)_2$ in 500 g of water.

Multiple Choice:

Print the letter (A, B, C, D, E) which corresponds to the answer selected.

10. _____ 11. _____ 12. _____ 13. _____

14. _____ 15. _____ 16. _____ 17. _____

18. _____

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 3 points.

10. When a liquid is placed in a closed container
A) evaporation stops.
B) evaporation continues for a time then stops
C) the vapor pressure above the liquid becomes one atmosphere.
D) evaporation and condensation continue to occur, but at equal speed.

11. When 0.00138 moles of hydrogen fluoride (HF) is added to 100.0 g of water, careful measurement of the freezing point of the solution shows it is lowered by 0.0281 ˚C. HF is a(n)

A) ionic compound.
B) weak electrolyte.
C) strong electrolyte.
D) nonelectrolyte.

12. A perchloric acid ($HClO_4$) solution is 59.0% by mass and it is also 9.18 M. Calculate the density of the solution.

A) 0.918 $g \cdot mL^{-1}$
B) 1.18 $g \cdot mL^{-1}$
C) 1.41 $g \cdot mL^{-1}$
D) 1.56 $g \cdot mL^{-1}$

13. A solution of 5.00 g of unknown *X* dissolved in 20.0 g of benzene freezes at –4.52 ˚C. Benzene normally freezes at 5.48 ˚C and is k_f is 5.12 $\frac{^\circ C}{m}$. What is unknown *X*?

A) naphthalene, $C_{10}H_8$
B) para-dichlorobenzene, $C_6H_4Cl_2$
C) menthol, $C_{10}H_{20}O$
D) some other compound

14. The molar masses of the three compounds diagrammed below are effectively the same (72). When the compounds are arranged in order of increasing boiling point (lowest boiling point first) what is the correct order?

I. $H_3C–CH_2–CH_2–CH_2–CH_3$
II. $H_3C–CH_2–CH_2–CH_2–OH$
III. $CH_3–CH_2–O–CH_2–CH_3$

A) I, II, III
B) II, I, III
C) II, III, I
D) III, I, II
E) I, III. II

15. Which of the following solutions will have the lowest vapor pressure at 25 ˚C?

A) 0.100 M $CaCl_2$
B) 0.100 M NaCl
C) 0.100 M $C_6H_{12}O_6$
D) 0.100 M NH_4NO_3

16. 0.200 g of $H_2O_{(l)}$ are introduced into an evacuated 250 mL container at 80 ˚C. The result is a container with
A) $H_2O_{(l)}$ only.
B) $H_2O_{(g)}$ only.
C) $H_2O_{(l)}$ and $H_2O_{(g)}$.
D) not enough information to accurately describe the phase(s) of water in the system.

17. Which factors do *not* affect the vapor pressure of a liquid at equilibrium?

I. Intermolecular forces of attraction
II. The volume of the liquid present.
III. The temperature of the liquid.

A) I only
B) II only
C) I and II only
D) II and III only

18. According to the phase diagram below, if the pressure is increased at constant temperature, from point A, what change will occur?

A) Solid will change to vapor.
B) Liquid will change to vapor
C) Liquid will change to solid
D) Solid will change to liquid

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

$PV = nRT$ $\qquad R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$

$P_{solution} = \chi_{solvent} P^{\circ}_{solvent}$ $\qquad$ density of $H_2O = 1.00 \frac{g}{cm^3}$

$\Delta T = ikm$ $\qquad k_f(H_2O) = 1.86 \frac{^{\circ}C}{m}$ $\qquad k_b(H_2O) = 0.512 \frac{^{\circ}C}{m}$

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