CHEM 1515
Exam I
John I. Gelder
February 3, 1993

Name _____

TA's Name _____

Lab Section _____

Please sign your name below to give permission to post, by student I.D. number, your course scores on homework, laboratories and exams.

_____
(signature)

INSTRUCTIONS:

1. This examination consists of a total of 9 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 5 - 7.

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	_____ (33)	_____ (19)	_____ (21)	_____ (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) $K_{(s)} + H_2O_{(l)} \rightarrow$

b) $Na_2CO_{3(s)} + HCl_{(aq)} \rightarrow$

c) $Na_3PO_{4(aq)} + Ba(NO_3)_{2(aq)} \rightarrow$

(15) 2. 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. For those compounds which dissolve, indicate whether the substances behaves as a non-, weak or strong electrolyte.

a) $C_6H_{12}O_{6(s)} \xrightarrow{H_2O}$

b) $C_4H_{8(l)} \xrightarrow{H_2O}$

c) $PbI_{2(aq)} \xrightarrow{H_2O}$

d) $NaC_2H_3O_{2(aq)} \xrightarrow{H_2O}$

e) $NH_4Cl_{(aq)} \xrightarrow{H_2O}$

(9) 3. Predict whether the following pairs (solute:solvent) form a solution when mixed together. In each case explain why or why not.

a) $CH_3NH_{2(g)} : H_2O_{(l)}$

b) $CS_{2(l)} : H_2O_{(l)}$

c) $CCl_{4(l)} : C_7H_{8(l)}$ (toluene)

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

a) $CH_3CH_2OH_{(l)}$

b) $SO_{2(s)}$

c) $CaF_{2(s)}$

d) $HNO_{3(l)}$

e) $Bi_{(s)}$

(9) 5. A sample of water vapor in a flask of constant volume exerts a pressure of 290 mmHg at 90.0 ˚C. The flask containing the water vapor is cooled to 75 ˚C, then to 65 ˚C and finally to 40 ˚C. Determine the pressure exerted by the water vapor in the flask at each of the lower temperatures.

(12) 6. An aqueous solution of barium chloride, $BaCl_2$, is 0.870 M and has a density of 1.077 $\frac{g}{mL}$ at 25 ˚C. Calculate the weight percent, the mol fraction, and the molality of barium chloride in the solution.

(9) 7. An aqueous solution of $NaHSO_4$ is prepared by adding 1.20 g $NaHSO_4$ in 250. g of water. The freezing point of the solution was experimentally measured and found to be –0.210 ˚C. Determine the van't Hoff factor, i, for this system and suggest what species (ions) are present in the solution.

Multiple Choice:

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

8. _____ 9. _____ 10. _____ 11. _____

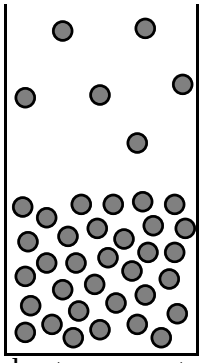
12. _____ 13. _____ 14. _____ 15. _____ 16. _____

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

8. Which of the following statements is true?

A) Mixing a solute and solvent will usually produce a solution if the overall solution process is highly endothermic.
B) Solids dissolve in solvents when the lattice energy of the solid, which is always endothermic, is greater than the hydration energy, which is always exothermic.
C) Solutions form when the energy released from solute:solvent interactions is greater than the sum of the solute:solute and solvent:solvent interactions.
D) The disorder resulting from mixing always works against the formation of a solution.

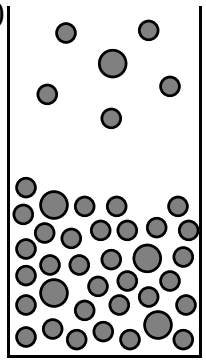
9. The diagram below represents a 2–dimensional model of a sample of water at a particular temperature.

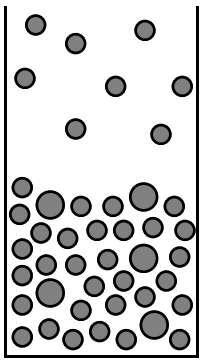


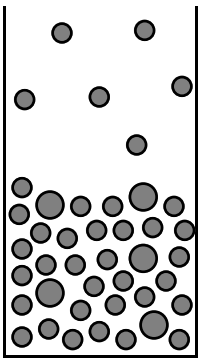
● H_2O

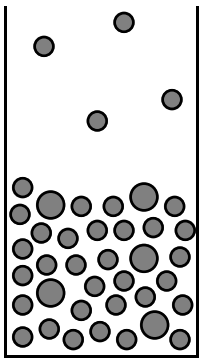
Which of the following diagrams best represents the same system following the addition of a sample of sucrose ($C_{12}H_{22}O_{11}$)?

where ● $C_{12}H_{22}O_{11}$

A) 

B) 

C) 

D) 

10. Rank the pure substances N_2, CH_3OH, Ar and CaO in terms of increasing strength of attractive forces

A) $N_2 < CH_3OH < Ar < CaO$
B) $N_2 < Ar < CH_3OH < CaO$
C) $CaO < CH_3OH < Ar < N_2$
D) $CH_3OH < CaO < Ar < N_2$

11. Which of the following statements is true?

A) For liquids with strong intermolecular attractive forces, e.g. hydrogen-bonding, the equilibrium vapor pressure can decrease with increasing temperature.
B) As intermolecular attractive forces increase the vapor pressure decreases and the boiling point increases.
C) In a closed system, the vapor pressure of a liquid depends on the volume of vapor above the liquid, whether liquid is present in the system or not.
D) The vapor pressure of a liquid depends on the surface area of the liquid.

12. If a certain amount of a nonvolatile, nonelectrolyte solute lowers the vapor pressure of 180.0 g of water by 0.30 mm Hg at 25 ˚C, how would the freezing point of the solution differ from that of the pure water? (P_{H_2O} = 23.8 mm Hg at 25 ˚C)

A) It would be lowered by 0.24 ˚C.
B) It would be lowered by 0.45 ˚C.
C) It would be lowered by 1.0 ˚C.
D) It would be lowered by 1.3 ˚C.

13. A solution has a mole fraction of K_2CO_3 of 0.0205. If the density of the solution is 1.09 $\frac{g}{mL}$, calculate the molarity of the solution.

A) 1.09 M
B) 1.00 M
C) 1.27 M
D) 1.16 M

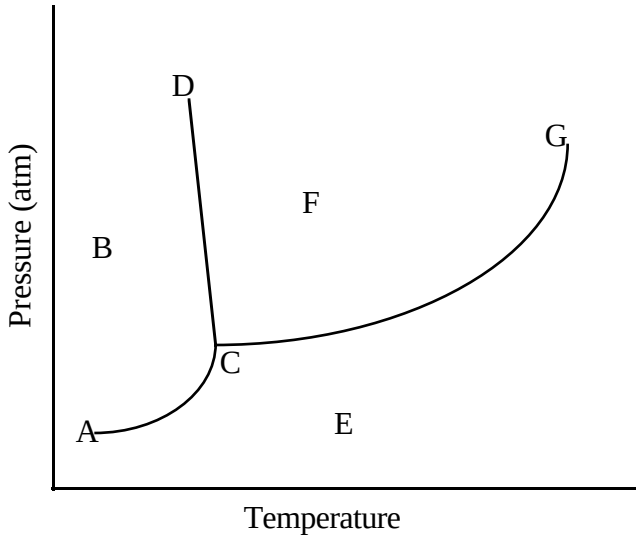
14. Benzoic acid behaves as a nonelectrolyte in the solvent naphthalene. When 10.0 g of benzoic acid is dissolved in 100. g of naphthalene the freezing point is depressed by 5.66 ˚C. (k_f(naphthalene is 6.9 $\frac{˚C}{m}$.) The molar mass of benzoic acid is;

A) 12.0 $\frac{g}{mol}$
B) 122 $\frac{g}{mol}$
C) 82.0 $\frac{g}{mol}$
D) 100. $\frac{g}{mol}$

15. Which of the following aqueous solutions has the lowest vapor pressure at 25 ˚C?

A) 0.0250 molal $(NH_2)_2CO$
B) 0.0250 molal K_2CO_3
C) 0.0250 molal NaCl
D) 0.0250 molal $C_{12}H_{22}O_{11}$
E) 0.0250 molal HF

16. Below is a representative phase diagram for a pure substance. Which of the following statements is false?



A) If the pressure at the triple point is greater than 1 atm, the substance can not exist as a liquid at 25 ˚C and 1 atm.
B) G is the critical point.
C) The melting point for this substance can be found at a particular pressure and temperature on the line CG.
D) The line AC defines the equilibrium between solid and vapor.

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 (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