CHEM 1515
Exam II
John II. Gelder

Name _____

TA's Name _____

Section _____

INSTRUCTIONS:

1. This examination consists of a total of 10 different pages. The last four pages include a periodic table; useful mathematical equations and constants; a table of vapor pressures for water; and a solubility table. 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 4, 7 and 8.

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	_____	_____	_____	_____	_____	_____
	(22)	(18)	(14)	(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) $Fe(NO_3)_{3(aq)} + KSCN_{(aq)} \rightarrow$

b) $Pb(NO_3)_{2(aq)} + NaI_{(aq)} \rightarrow$

c) $Al_{(s)} + Br_{2(l)} \rightarrow$

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

Ionic equation

Net Ionic equation

(9) 3. Describe the reaction between $Fe(NO_3)_{3(aq)}$ and $KSCN_{(aq)}$. In your description include the phase and color of the reactants, and the phase and color of the products. Indicate the balanced net ionic equation that represents the chemical reaction that occurs. Based on our classroom discussion of this reaction what makes the reaction interesting?

(18) 4. Orange juice is 10.0% sugar. For purposes of this problem, we will assume all the sugar in orange juice is sucrose, $C_{12}H_{22}O_{11}$, and the remainder can be assumed to be water. Calculate each of the following;

a) the molality of sugar in orange juice;

b) the mol fraction of sugar in orange juice;

c) the molarity of sugar in orange juice (note: the density of orange juice can assumed to be 1.040 g mL^{-1}.);

(9) 5. For the reaction

$$Br_2(g) + Cl_2(g) \rightleftharpoons 2\ BrCl(g)$$

When 0.30 mol of Br_2 and 0.30 mol of Cl_2 are introduced into a 1.0 L container. When equilibrium is established the amount of BrCl is 0.34 mol.

a) Calculate K_c for the reaction. (6)

b) If 0.25 mol BrCl are added to the equilibrium mixture in the 1.0 L container;
   i) Which direction will the reaction proceed to re-establish equilibrium? Explain in terms of Q (the nonequilibrium reaction quotient) and K_c. (3)

(12) 7a. Caffeine, a compound that contains C, H, N and O, is a nonelectrolyte when dissolved in water. Calculate the molar mass of caffeine if the ideal freezing point of water is –0.210 ˚C when 1.504 g of caffeine dissolve in 68.40 g of water.

b) Calculate the ideal boiling point of this same solution.

(7) 8. Ammonia can be prepared from its elements according to the reaction

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

a) K_c for the reaction is 0.111 at this temperature. If the equilibrium concentration for NH_3 is 0.0225 M and for N_2 the equilibrium concentration is 0.114 M, calculate the equilibrium concentration for H_2.

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

9. _____ 10. _____ 11. _____ 12. _____

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

17. _____

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

9. Which of the following aqueous solution would have the highest boiling point, assuming ideal behavior?

(A) 0.0250 molal $C_6H_{12}O_6$

(B) 0.0300 molal $MgCl_2$

(C) 0.0400 molal KCl

(D) 0.0500 molal $(NH_2)_2CO$

(E) 0.0250 molal NH_4ClO_4

10. A seal 1.00 L container initially holds 0.00623 mol of H_2, 0.00414 mol of I_2 and 0.0244 mol of HI at 703 K. When equilibrium is established there are 0.00467 mol of H_2. Calculate K_C for the reaction

$$I_{2(g)} + H_{2(g)} \rightleftharpoons 2HI_{(g)}$$

(A) 5.66×10^{-4}
(B) 2.66×10^{-2}
(C) 37.6
(D) 53.0
(E) 1768

11. Order the following substances from highest to lowest melting point:

Glucose ($C_6H_{12}O_6$), sand (SiO_2), pyrite (FeS), gasoline (C_8H_{18})

(A) pyrite, glucose, sand, gasoline;

(B) sand, glucose, pyrite, gasoline;

(C) pyrite, sand, glucose, gasoline;
(D) sand, pyrite, glucose, gasoline;
(E) gasoline, glucose, sand, pyrite.

12. KI, an ionic solid, dissolves in water with an enthalpy of solution that is endothermic. Which of the following best describes the solution process for this system;

(A) the lattice energy for the ionic solid is more positive than the absolute value of the hydration energy, and the change in entropy is positive;

(B) the enthalpy of the solution process is positive and the entropy change of the solution process is negative;

(C) the enthalpy of the solution process is negative and the entropy change of the solution process is positive;

(D) less heat is required to separate both the solute and the solvent particles, compared to the heat released when the solute-solvent attractions are formed, and the entropy of the solution process is positive;

(E) the heat required to separate the solute particles is smaller than the heat required to separate the solvent molecules plus the heat released when the water molecules hydrate the cation and anion, and the entropy of the solution process is positive.

13. Which of the following compounds would be the most soluble in CCl_4?

(A H_2O

(B) CH_3OH

(C) $CH_3CH_2CH_2OH$

(D) $CH_3CH_2CH_2CH_2CH_2OH$

(E) $CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$

14. The experimental freezing point of a 0.150 molal aqueous solution of H_2SO_4 was measured as -0.569. Which of the following statements would be supported by this experimental data?

(A) H_2SO_4 does not dissociate in water.

(B) H_2SO_4 dissociates into H^+ and HSO_4^- ions.

(C) H_2SO_4 dissociates into $2H^+$ and SO_4^{2-} ions.

(D) H_2SO_4 dissociates into $2H^+$, SO_3 and O^{2-} ions.

(E) H_2SO_4 associates into $(H_2SO_4)_2$.

15. An ionic compound containing potassium and an unknown element X has the formula K_2X. K_2X is soluble in water. When 1.38 grams of this compound is dissolved in 100.0 gram of water the ideal freezing point is –0.558 ˚C. Calculate the molar mass of the anion X^{2-}.

(A) 14.5 g mol^{-1}

(B) 46.1 g mol^{-1}

(C) 60.0 g mol^{-1}

(D) 92.8 g mol^{-1}

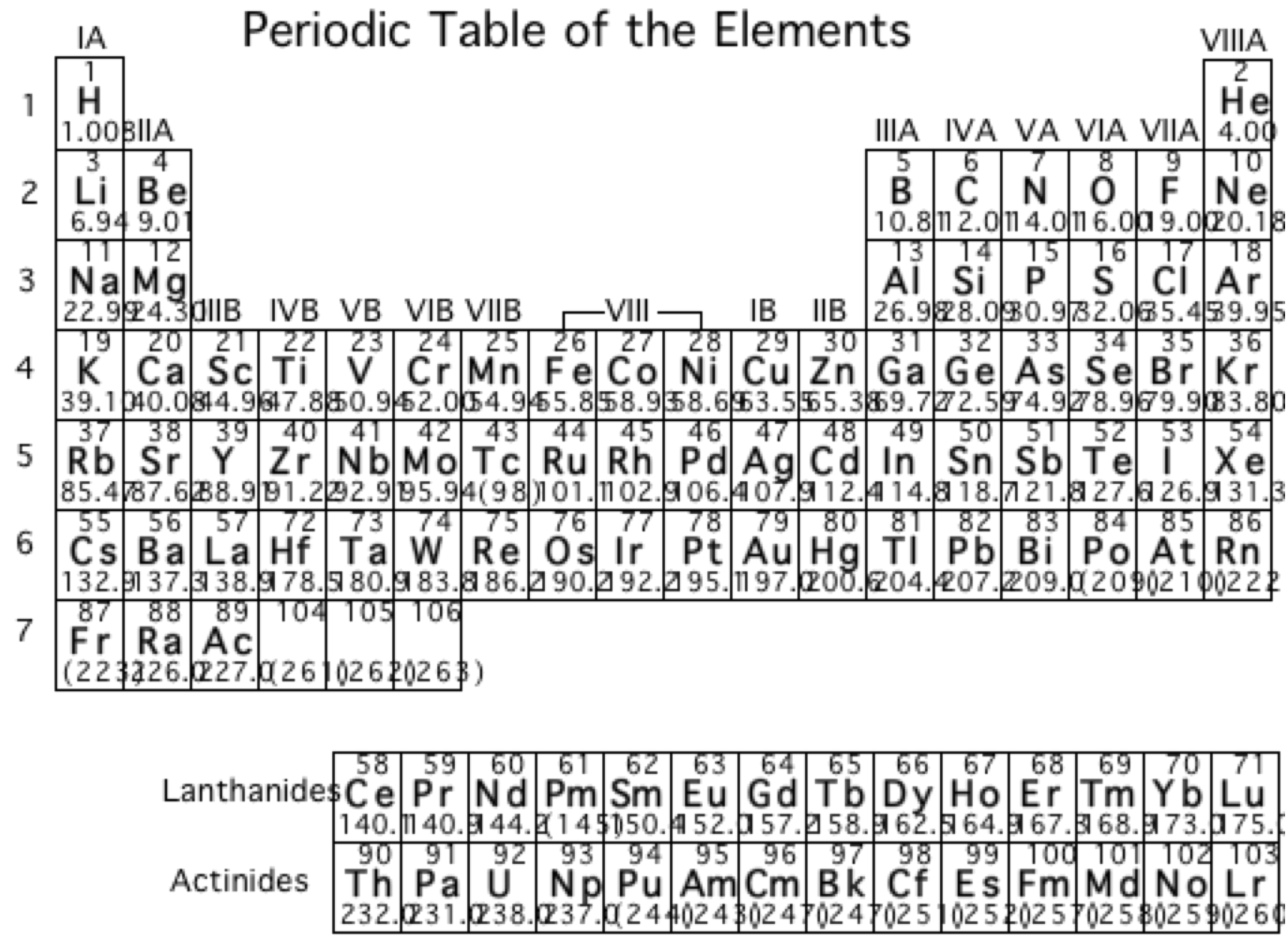
(E) 276 g mol^{-1}.

16. An aqueous solution of iron (III) chloride, $FeCl_3$, has a mol fraction of $FeCl_3$ that is 0.0210. The weight percent of $FeCl_3$ in this solution is,

    (A) 2.10%
    (B) 3.41%
    (C) 8.10%
    (D) 16.2%
    (E) 19.3%.

17. Formic acid is known to be a weak electrolyte. Estimate a reasonable freezing point for a solution of formic acid prepared by mixing 2.56 g of HCOOH in 12.0 g of water.

    (A) -8.63 ˚C
    (B) -1.86 ˚C
    (C) -17.2 ˚C
    (D) -1.96 ˚C
    (E) -9.14 ˚C



Useful Information

$1\ nm = 10^{-9}\ m$ $\quad R = 0.0821\ \frac{L \cdot atm}{mol \cdot K} = 8.314\ \frac{J}{mol \cdot K}$ $\quad 6.02 \times 10^{23}$

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

$\Delta T = i k m$ $\quad k_f(H_2O) = 1.86\ \frac{^{\circ}C}{m}$ $\quad k_b(H_2O) = 0.52\ \frac{^{\circ}C}{m}$

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

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