CHEM 1515 Sections 20511 & 20516
Exam I
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Name _____

TA's Name _____

Section _____

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last two pages include a periodic table, useful mathematical equations, 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 5a.
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	MC	TOTAL
SCORES	_____	_____	_____	_____	_____	_____
	(27)	(12)	(22)	(23)	(16)	(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.

a) $H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow$

b) $C_7H_{16(l)} + O_{2(g)} \rightarrow$

c) $HC_2H_3O_{2(aq)} + NaHCO_{3(s)} \rightarrow$

(4) 2. Write the ionic and net ionic chemical equations for reaction 1a.

1a) Ionic equation:

1a) Net Ionic equation:

(26) 3. The element iodine, $I_{2(g)}$, a diatomic molecule, undergoes deposition according to the chemical equation below,

$$I_{2(g)} \rightarrow I_{2(s)}$$

(i) Which phase of iodine has the greater absolute entropy? Explain. (7)

(ii) Which phase of iodine has the lower absolute entropy? Explain. (7)

3. (Continued) The element iodine, $I_{2(g)}$, a diatomic molecule, undergoes deposition according to the chemical equation below,

$$I_{2(g)} \rightarrow I_{2(s)}$$

(iii) Is ΔH° for the deposition of iodine positive or negative? (3)

(iv) Is ΔS° for the deposition of iodine positive or negative? (3)

(v) Based on parts (iii) and (iv), is the phase change described above thermodynamically favored at high temperature or a low temperature? Explain. (6)

$$\frac{1}{2}\,Br_{2(l)} + \frac{1}{2}\,Cl_{2(g)} \rightarrow BrCl_{(g)}$$

(22) 4a. Is the above reaction a formation reaction? Yes or No? (Circle your choice) (2)
Explain. (3)

(b) Predict the sign of ΔS° for the above reaction between $Br_{2(l)}$ and $Cl_{2(g)}$. (3)

_____

Describe the evidence used to support your claim. (5)

(c) The boiling point of Br_2 is 332K, whereas the boiling point of BrCl is 278 K. Explain this difference in boiling point in terms of the polarity of each substance and all of the intermolecular attractive forces present between molecules of each substance. (9)

(23) 5. One of many possible reactions between ammonia and oxygen is show below.

$$2\ NH_{3(g)} + 2\ O_{2(g)} \rightarrow N_2O_{(g)} + 2\ H_2O_{(g)}$$

Compound	ΔH_f° (kJ mol^{-1})	S°(J mol^{-1} K^{-1})	ΔG_f°(kJ mol^{-1})
$NH_{3(g)}$	-46	?	-16.5
$O_{2(g)}$	0	205	0
$N_2O_{(g)}$	+82.1	220	104
$H_2O_{(g)}$	-242	189	-229

a) Calculate ΔH°_{rxn}, ΔS°_{rxn}, and ΔG°_{rxn} for the reaction above at 298 K. (20)

b) Is the reaction thermodynamically favored or not thermodynamically favored at 298 K? Explain. (3)

Multiple Choice: (16 points)

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

6. _____ 7. _____ 8. _____ 9. _____

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 4 points.

Questions 6 and 7. Use the table of equilibrium vapor pressures for ethanol, $CH_3CH_2OH(l)$

Temperature (˚C)	Vapor Pressure (mm Hg)
72	600
65	450
52	250
33	100

6. A sample of ethanol in a constant volume container at 75 ˚C exerts a pressure of 550 mm Hg. The sample is cooled to 52 ˚C.

A. the sample condenses and the pressure exerted by the vapor is 513 mm Hg
B. the sample condenses and the pressure exerted by the vapor is 250 mm Hg
C. the sample remains in the vapor phase and the pressure exerted by the vapor is 513 mm Hg
D. the sample remains in the vapor phase and the pressure exerted by the vapor is 381 mm Hg
E. the sample begins as vapor at 75 ˚C and remains as vapor with the new pressure exerted by the vapor less than 250 mm Hg

7. Calculate the enthalpy of vaporization for $CH_3CH_2OH(l)$

A. 40.4 kJ mol^{-1} B. 33.2 kJ mol^{-1} C. 78.0 kJ mol^{-1} D. -155 kJ mol^{-1} E. 26.5 kJ mol^{-1}

For Questions 8 and 9:

Consider the following attractive forces

I. London dispersion forces
II. Dipole dipole forces
III. Hydrogen bonding forces
IV. Covalent bonds
V. Ionic bonding

8. Which forces must be overcome when CH_2F_2 boils?

A. I only
B. II only
C. I and II
D. I and III
E. I, II and III

9. Which forces must be overcome when CH_3OH boils?

A. I only
B. II only
C. I and II
D. I and III
E. I, II and III

PERIODIC TABLE OF THE ELEMENTS

1												13	14	15	16	17	18
1 H 1.008	2																2 He 4.00
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
11 Na 22.99	12 Mg 24.30	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (97)	44 Ru 101.1	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 †Ac (227)	104 Rf (267)	105 Db (270)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (282)	112 Cn (285)	113 Uut (285)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

	58	59	60	61	62	63	64	65	66	67	68	69	70	71
*Lanthanoid Series	Ce 140.12	Pr 140.91	Nd 144.24	Pm (145)	Sm 150.4	Eu 151.97	Gd 157.25	Tb 158.93	Dy 162.50	Ho 164.93	Er 167.26	Tm 168.93	Yb 173.05	Lu 174.97
	90	91	92	93	94	95	96	97	98	99	100	101	102	103
†Actinoid Series	Th 232.04	Pa 231.04	U 238.03	Np (237)	Pu (244)	Am (243)	Cm (247)	Bk (247)	Cf (251)	Es (252)	Fm (257)	Md (258)	No (259)	Lr (262)

Useful Information

$PV = nRT$ $\qquad R = 0.0821 \frac{L \cdot atm}{mol \cdot K} = 8.314 \frac{J}{mol \cdot K}$

$\ln\left(\frac{vp_2}{vp_1}\right) = -\frac{\Delta H^\circ_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$ $\qquad$ density of $H_2O = 1.00 \frac{g}{cm^3}$

$\Delta H^\circ_{rxn} = \sum m\Delta H_f^\circ(\text{products}) - \sum n\Delta H_f^\circ(\text{reactants})$

$\Delta S^\circ_{rxn} = \sum mS^\circ(\text{products}) - \sum nS^\circ(\text{reactants})$

$\Delta G^\circ_{rxn} = \sum m\Delta G_f^\circ(\text{products}) - \sum n\Delta G_f^\circ(\text{reactants})$

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

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