CHEM 1314
Exam IV
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Name ____________________
TA Name ____________________
Lab Section ____________________

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last three pages includes a periodic table and some useful information, a solubility table, a table of vapor pressures and a table of standard heats of formation. All work should be done in this booklet.

2. PRINT your name, teaching assistant's name and lab section 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 1, 2, and 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	____ (30)	____ (16)	____ (40)	____ (14)	____ (100)

(15) 1. The volume of a weather balloon containing He gas at 25.0 ˚C and 1.04 atm is 244 L. After released the balloon ascends to an altitude where the pressure falls to 0.120 atm and the temperature is –53.0 ˚C. Assuming no gas is lost as the balloon ascends, calculate the volume of the balloon under these new conditions.

(15) 2. A common laboratory preparation of O_2, involves the decomposition of potassium chlorate, $KClO_3$, according to the equation

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

Typically the oxygen gas is collected by displacing water. If the collected gas from the decomposition of 0.869 g of $KClO_3$ is at a temperature of 25.0 ˚C and exerts a pressure of 1.00 atm, calculate the volume of O_2 produced?

(8) 3. Explain, in terms of the kinetic molecular model, why increasing the temperature of a sample of an ideal gas increases the pressure of the gas. Assume the volume and number of moles of gas are held constant.

(8) 4. van der Waal's equation for a real gas is,

$$\left(P + a\left(\frac{n}{V}\right)^2\right)(V - bn) = nRT$$

a. Briefly explain what property of a real gas is accounted for by the constant *a* ?

b. Why is the $a\left(\frac{n}{V}\right)^2$ term added to P in the van der Waal's equation?

(10) 5. Using the following standard enthalpy of reaction data and Hess' Law calculate the heat of reaction for the coal gasification process described by the equation,

$$2C(s) + 2H_2O(l) \rightarrow CH_4(g) + CO_2(g)$$

Reaction	ΔH°_{rxn}
1. $C(s) + H_2O(l) \rightarrow CO(g) + H_2(g)$	131.3 kJ
2. $CO(g) + H_2O(l) \rightarrow CO_2(g) + H_2(g)$	-41.2 kJ
3. $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$	-206.1 kJ

Clearly demonstrate how the given equations (1 - 3) are to be manipulated to obtain the final equation.

(15) 6. The reaction

$$2N_2H_4(l) + N_2O_4(l) \rightarrow 3N_2(g) + 4H_2O(g)$$

is a reaction of the type used by the Apollo Lunar landing craft. Using the Table of Standard Heats of Formation, calculate the ΔH° for this reaction.

(15) 7. A 5.00 g sample of KCl is dissolved 1.00 kg of water contained in an OSU type calorimeter. The observed temperature decrease was 0.256 ˚C. The heat capacity of the calorimeter is 326 $\frac{J}{^\circ C}$. Calculate the molar heat of solution of potassium chloride. (Assume the specific heat of the solution is the same as that for water.)

Multiple Choice:

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

8. _________ 9. _________ 10. _________ 11. _________

12. _________ 13. _________ 14. _________

ONLY THE ANSWERS IN THE AREA ABOVE WILL BE GRADED. Select the most correct answer for each question. Each question is worth 2 points.

8. If the pressure of an ideal gas is tripled and the temperature halved the new volume can be expressed as; (Note: assume the number moles of the ideal gas remain constant.)

A) $V_{new} = 0.06 \cdot V_{initial}$
B) $V_{new} = 0.167 \cdot V_{initial}$
C) $V_{new} = 0.667 \cdot V_{initial}$
D) $V_{new} = 1.5 \cdot V_{initial}$

9. Which of the following gases will effuse more rapidly?

A) O_2
B) Ar
C) HCl
D) H_2S

10. Which of the following compounds is expected to have the <u>lowest</u> vapor pressure at 25.0 ˚C?

A) CH_3OCH_3
B) CH_3OH
C) $CH_3CH_2CH_2CH_3$
D) $CH_3CH_2CH_3$

11. Which of the following molecules exhibit hydrogen bonding in the pure liquid?

A) HBr
B) CH_4
C) PH_3
D) N_2H_4

12. 0.135 g of H_2O are introduced into a 500.00 mL flask at 50.0 ˚C. Which of the following statements is true?

A) only vapor is present in the flask.
B) only liquid is present in the flask.
C) both liquid and vapor are present in the flask.
D) not enough information to determine the phase(s).

Given the list of intermolecular attractive forces;

1. ion - dipole
2. dipole - dipole
3. London dispersion
4. Hydrogen bonding

Answer the Questions 13 and 14.

13. Which intermolecular attractive force(s) occur in a pure liquid sample of CO?

A) 2 only
B) 3 only
C) 4 only
D) 2 and 3
E) 3 and 4

14. Which intermolecular attractive force(s) occur in a pure liquid sample of XeF_4?

A) 2 only
B) 3 only
C) 4 only
D) 2 and 3
E) 3 and 4

Useful Information

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	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)

specific heat of water is $4.184 \frac{J}{g\cdot°C}$

$PV = nRT$

$R = 0.08203 \frac{L\cdot atm}{mol\cdot K}$ or $R = 8.314 \frac{J}{mol\cdot K}$

$\Delta H^{\circ}_{rxn} = \Sigma\, n\Delta H^{\circ}_{f}\text{(products)} - \Sigma\, m\Delta H^{\circ}_{f}\text{(reactants)}$

q(heat flow) = mass · specific heat · ΔT

$\Delta H = \Delta E + \Delta nRT$

$\Delta E = q - w$

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

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

Table of Standard Heats of Formation

Substance and State	ΔH_f° (kJ/mol)	Substance and State	ΔH_f° (kJ/mol)
C(*s*) (graphite)	0	HCl(*g*)	-92.3
C(*s*) (diamond)	2	HBr(*g*)	-36.4
CO(*g*)	-110.5	HI(*g*)	26.5
$CO_2(g)$	?	$I_2(g)$	62.25
$CH_4(g)$	?	$O_2(g)$	0
$CH_3OH(g)$	-201	O(*g*)	249
$CH_3OH(l)$	-239	$O_3(g)$	143
$H_2CO(g)$	-116		
$CCl_4(l)$	-135.4	$N_2(g)$	0
HCOOH(*g*)	-363	$NH_3(g)$	-46
HCN(*g*)	135.1	$NH_3(aq)$	-80
$CS_2(g)$	117.4	$NH_4^+(aq)$	-132
$CS_2(l)$	89.7	$N_2H_3CH_3(l)$	54
$C_2H_2(g)$	227	$N_2H_4(l)$	50.6
$C_2H_4(g)$	52	NO(*g*)	90.25
$CH_3CHO(g)$	-166	$NO_2(g)$	33.18
$C_2H_5OH(l)$	-278	$N_2O(g)$	82.0
$C_2H_5O_2N(g)$	-533	$N_2O_4(g)$	9.16
$C_2H_6(g)$	-84.7	$N_2O_4(l)$	20
$C_3H_6(g)$	20.9	$HNO_3(aq)$	-207.36
$C_3H_8(g)$	-104	$HNO_3(l)$	-174.10
$CH_2 = CHCN(l)$	152	$NH_4ClO_4(s)$	-295
$CH_3COOH(l)$	-484		
$C_6H_{12}O_6(s)$	-1275	$SO_2(g)$	-296.83
$TiO_2(s)$	-945	$H_2S(g)$	-20.6
$Cl_2(g)$	0	$SOCl_2(g)$	-213
$Cl_2(aq)$	-23	$S_2Cl_2(g)$	-18
$Cl^-(aq)$	-167		
		$SiO_2(s)$	-910.94
		$SiF_4(g)$	-1614.9
$H_2(g)$	0	$SiCl_4(g)$	-657
H(*g*)	217		
$H^+(aq)$	0	$TiCl_4(g)$	-763
$OH^-(aq)$	-230	$TiO_2(s)$	-944.7
$H_2O(l)$	-286		
$H_2O(g)$	-242		