CHEM 1314
Exam V
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December 14, 1992

Name _____
TA Name _____

Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 12 different pages. The last three pages includes a periodic table, a table of standard heats of formation, a solubility table and some useful equations and constants. 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 problem 4.

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	_____	_____	_____	_____	_____	_____
	(32)	(30)	(31)	(9)	(48)	(150)

(9) 1. Write the chemical formula(s) of the product(s) and balance each of the following reactions. Identify all product phases as either (g)as, (l)iquid, (s)olid or (aq)ueous.

a) $Ba(OH)_2 \cdot 8H_2O_{(s)} + NH_4SCN_{(s)} \rightarrow$

b) $H_2SO_{4(aq)} + KOH_{(aq)} \rightarrow$

c) $Na_2CO_{3(s)} + FeCl_{3(aq)} \rightarrow$

(4) 2. Write the ionic and the net ionic equation for any **one** of the equations in Problem #1.

(19)3a. Complete the table below by drawing the Lewis electron-dot structures for CH_4, NH_3 and H_2O, indicating the molecular geometry and the H–X–H bond angle (where X is C, N or O) for each of the three compounds.

	CH_4	NH_3	H_2O
Lewis Structure			
Molecular Geometry			
H–X–H Observed Bond Angle			

b. Since the electron-pair geometry is the same in all three compounds, explain the trend in the observed bond angle for each compound.

(30)4a. A 0.3492 g sample of an unknown organic compound containing carbon, hydrogen and oxygen was analyzed and found to contain 55.78% C and 7.04% H with the remainder oxygen. Determine the empirical formula of this compound.

b. When a 0.3492 g sample of the unknown organic compound is vaporized at 80.0 ˚C and 750. mmHg it is found to occupy a volume of 120. mL. Determine the molar mass and the molecular formula of the unknown compound.

c. If 7.00 g of the compound are combusted with 7.00 g of oxygen, calculate the moles of $CO_{2(g)}$ and $H_2O_{(l)}$ formed.

(10) 5. Define the term *ionization energy* and indicate the overall trend in the first ionization energy for the elements in a period. Explain why the first ionization energy for an oxygen atom does not adhere to that predicted by the overall trend going across the period.

6. Short answer.

(8) a. Complete the following table

Name of Compound	Formula of Compound	Ionic or Covalent
ammonium sulfate		
	N_2O	

(2) b. Report the result of the following calculation to the correct number of significant figures.

$6.783 \times 10^{-4} - 8.3 \times 10^{-6} =$

(2) c. Name two liquids which when mixed together form a homogeneous mixture.

(6) d. How many electrons, protons and neutrons are in the isotope ${}^{34}_{16}S^{2-}$?

e^- _____ p^+ _____ n^o _____

(3) e. How much energy is required to remove an electron from a hydrogen atom initially in its ground state?

Short Answer (CONTINUED)

(4) f. Give a set of quantum numbers for an electron in one of the 5*d* orbitals.

(2) g. Suggest a formula for a compound containing magnesium and nitrogen.

(3) h. How many oxygen atoms are contained in a sample of $KAl(SO_4)_2$ with a mass of 2.143×10^{-21} g?

Multiple Choice:

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

7. _____	8. _____	9. _____	10. _____
11. _____	12. _____	13. _____	14. _____
15. _____	16. _____	17. _____	18. _____
19. _____	20. _____	21. _____	22. _____

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

7. What is the concentration of NO_3^- ions in a solution which is 0.500 M $Mg(NO_3)_2$ and 1.00 M $Al(NO_3)_3$?

   A) 0.500 M
   B) 1.50 M
   C) 2.75 M
   D) 3.50 M
   E) 4.00 M

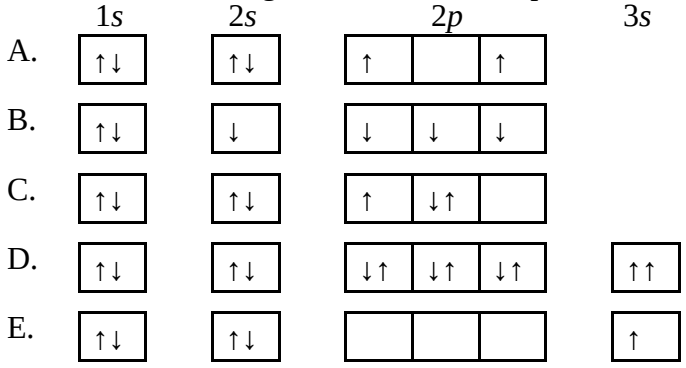
8. Which of the following species violates the octet rule?

   A) N_2O_5
   B) O_3
   C) NO
   D) BH_4^-

9. Which of the following statements is false?

   A) An orbital describes the region of space with the greatest probability of finding an electron.
   B) The consideration of Heisenberg's Uncertainty Principle and de Broglie's matter waves account for the difference between the behavior of the electron in Bohr's model and the quantum mechanical model of the hydrogen atom.
   C) Louis de Broglie proposed that particles of matter should be associated with wave-like behavior.
   D) When an electron in an atom is excited it simultaneously emits a photon of light of the same energy.

10. From the orbital diagrams select an example which demonstrates an atom in its ground state.



Use the following information to answer Questions 11 and 12.

1.258 g of O_2 are mixed with 2.015 g of SO_2 are allowed to react at 423 K. After the reaction occurs 1.728 g of SO_3 are produced according to the equation below. (Note: Molar mass of O_2 = 32.0 $\frac{g}{mol}$, SO_2 = 64.0 $\frac{g}{mol}$ and SO_3 = 80 $\frac{g}{mol}$.)

$$O_{2(g)} + 2SO_{2(g)} \rightarrow 2SO_{3(g)}$$

11. How many grams of O_2 remain after the reaction reaches completion?

A) 0 g
B) 0.346 g
C) 0.567 g
D) 0.691 g
E) 0.912 g

12. If the initial pressure of the mixture of oxygen and sulfur dioxide is P_i. Which of the following statements best describes the total pressure exerted by the reaction mixture after the reaction reaches completion? Assume the temperature remains constant in a container of fixed volume.

A) P_f is greater than P_i.
B) P_f is less than P_i.
C) P_f is equal to P_i.
D) Not enough information to determine an answer.

Use these responses for Questions 13 and 14.

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 2d^{10}\ 3p^6$
D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$
E. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^3$

13. An impossible electron configuration.

14. The ground-state configuration of a negative ion of a halogen.

15. Which of the following gas mixtures exerts the greater pressure? Assume each mixture is in the same size volume at the same temperature

A) 2.00 g of H_2, 4.00 g of He and 40.0 g of Ar
B) 2.00 g of H_2, 6.00 g of He and 40.0 g of Ar
C) 4.00 g of H_2, 4.00 g of He and 40.0 g of Ar
D) 2.00 g of H_2, 4.00 g of He and 50.0 g of Ar

16. Which of the following are reasonable values for the first four ionization energies for Al?

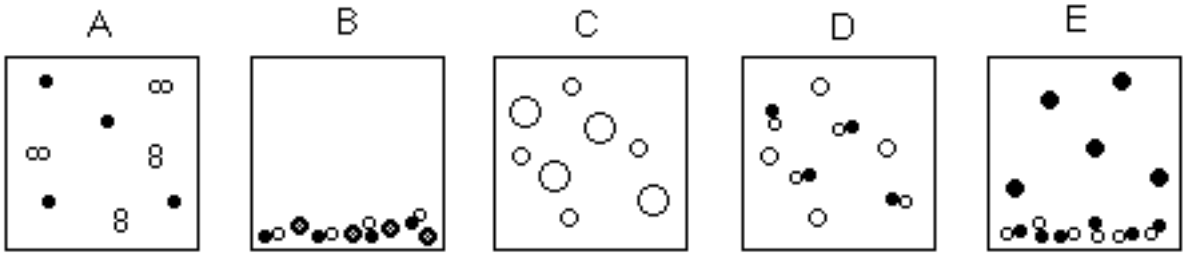
	1st	2nd	3rd	4th
A)	496 kJ	4562 kJ	6912 kJ	9543 kJ
B)	578 kJ	1817 kJ	2744 kJ	11,577 kJ
C)	738 kJ	1451 kJ	7733 kJ	10,540 kJ
D)	657 kJ	1269 kJ	2136 kJ	2752 kJ

17. Consider the exothermic reaction: $H_2\,(g) + I_2\,(g) \rightarrow 2\,HI\,(g)$. Which of the following is true?
    A) If the reaction occurs at constant pressure ΔH° is negative, and $\Delta H^\circ = \Delta E^\circ$
    B) If the reaction occurs at constant pressure ΔH° is positive, and $\Delta H^\circ = \Delta E^\circ$
    C) If the reaction occurs at constant pressure ΔH° is negative, and $\Delta H^\circ \neq \Delta E^\circ$
    D) If the reaction occurs at constant pressure ΔH° is positive, and $\Delta H^\circ \neq \Delta E^\circ$
    E) $\Delta H^\circ_{rxn} = \Delta H^\circ_f\,(HI(g))$

18. Which of the following reactions has a positive ΔH?

    A) $CO_{2(s)} \rightarrow CO_{2(g)}$
    B) $2CH_3OH_{(l)} + 3O_{2(l)} \rightarrow 2CO_{2(g)} + 4H_2O_{(l)}$
    C) $2K_{(l)} + 2H_2O_{(l)} \rightarrow 2KOH_{(g)} + H_{2(g)}$
    D) $Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

19. Which of the following diagrams represents a solution of hydrogen and helium at 25 ˚C and 1 atm?



    A) A
    B) B
    C) C
    D) D
    E) E

20. Which of the following statements about an ideal gas is false?

    A) The forces of attraction between gas particles are assumed to be negligible.
    B) Nonreactive gases will mix in any proportion and behave independently of each other.
    C) The volumes of the gas particles are assumed to be negligible compared to the volume of the container.
    D) At a constant temperature, all the molecules are assumed to have the same speed.

21. Which of the following statement is false?

    A) An exothermic reaction is characterized by a negative value of ΔH.
    B) For an endothermic reaction the surrounding to absorb heat.
    C) Heat is evolved in an exothermic reaction.
    D) Heat is added to the system by an endothermic reaction.

22. Consider the following specific heats of metals

Metal	Specific Heat $\frac{J}{g \cdot °C}$
Copper	0.385
Cobalt	0.418
Chromium	0.447
Gold	0.129
Silver	0.237

If the same amount of heat is added to 100. g samples of each of the metals, which are all at the same temperature initially, which metal will reach the highest temperature

A) Copper
B) Cobalt
C) Chromium
D) Gold
E) Silver

Useful Information

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)

1 pound = 453.59237 g
1 L = 1.056718 qt
1 inch = 2.54 cm

ave. atomic mass = $\sum$ [(isotopic mass)·(fractional abundance)]

1 atm = 760 mmHg

$^{\circ}F = \frac{9}{5}\ ^{\circ}C + 32$

$K = {}^{\circ}C + 273.15$

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

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

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

$\Delta E = q - w$

q (heat) = mass · specific heat · ΔT

Avogadro's number is 6.02×10^{23}

$E_n = -R_H \left(\frac{1}{n^2}\right)$

$R_H = 2.18 \times 10^{-18}$ J

$\lambda = \frac{c}{\nu}$

$c = 3.00 \times 10^{8}\ \frac{m}{s}$

$E = h\nu$

$h = 6.626 \times 10^{-34}$ J·s

$PV = nRT$

$R = 0.08206\ \frac{L\cdot atm}{mol\cdot K}$

$$R = 8.314 \frac{J}{K \cdot mol}$$

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		

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