CHEM 1314.05
Exam III
John III. Gelder
November 15, 1994

Name _____

TA's Name _____

Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last three pages include a periodic table, a solubility table, a table of bond energies 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 4 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	Page 7	TOTAL
SCORES	_____	_____	_____	_____	_____	_____	_____
	(23)	(15)	(19)	(14)	(21)	(8)	(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) $Ba(NO_3)_{2(aq)} + Na_2SO_{4(aq)} \rightarrow$

b) $(NH_4)_2S_{(aq)} + Fe(NO_3)_{3(aq)} \rightarrow$

c) $KI_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow$

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

(10) 3. Explain the differences and similarities between the nature of the electron in the hydrogen atom according to the Bohr model and the Quantum Mechanical model. In your discussion be sure to discuss the difference in how the electron moves, the difference between an orbit and an orbital, the number of quantum numbers required to define the energy of the electron, and why the energy of the light emitted by excited hydrogen atoms is quantized.

(15) 4. Consider the first five energy levels (n = 1, 2, 3 4 and 5) the electron can occupy in a hydrogen atom.

a) Between which two adjacent levels, is the energy separation the smallest?

b) Calculate the magnitude of the energy separation between these two levels.

c) Calculate the wavelength of light absorbed to excite the electron between the two levels.

(13) 5. Draw a possible Lewis electron-dot structure for each of the covalent molecules below. Include all resonance structures if they are needed to adequately represent the bonding in the molecule.

(a) $CHCl_3$

(b) C_2H_5COOH

(c) HCO_3^-

(6) 6. Which has the smaller atomic radius, Al or S? Explain your answer in terms of effective nuclear charge and shielding effects.

(8) 7. Complete the following table

Compound	Name of molecular geometry
BrO_3^-	
SCl_2	
ClF_3	
NO_2^-	

(6) 8. If ΔH_f° for $SO_{2(g)}$ is $-297 \frac{kJ}{mol}$, estimate the sulfur–sulfur bond energy in elemental sulfur, S_8. Why is the calculated value only an estimate? Assume that SO_2 contains two S=O bonds.

(21) 9. Short answer.

(4) a) Which of the following has the highest lattice energy

$$KCl,\ AlCl_3,\ NaCl,\ MgCl_2,\ RbCl$$

Briefly, explain your choice.

(4) b) Write a possible set of quantum numbers for two of the valence electron in a tin (Sn) atom in its ground state.

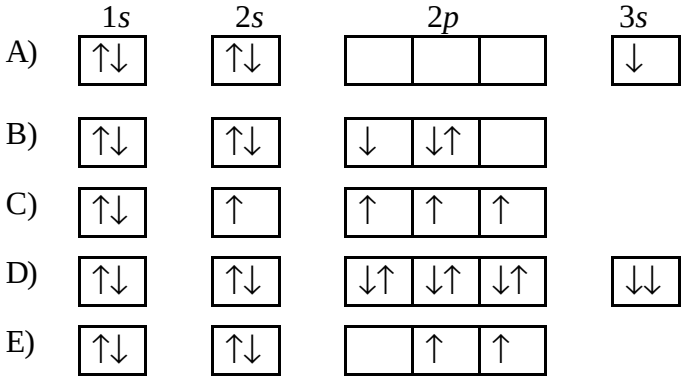
(6) c. Write the electron configuration for,

i. Cl

ii. Ni^{2+}

iii. Dy

(5) d) Given the five orbital diagrams labeled A, B, C, D, and E.



From the orbital diagrams select an example which demonstrates

i). a violation of the Aufbau principle

ii). a ground state orbital diagram

iii). a violation of Hund's rule

iv). a violation of the Pauli exclusion principle

v). an excited state orbital diagram

(2) e. An unknown neutral element, X, has only 5 electrons in its *p* subshell. What is the formula of the compound formed between this unknown element and calcium?

Multiple Choice: (8 points)

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

10. _____ 11. _____ 12. _____ 13. _____

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

10. Which of the following neutral atoms, when in the gas phase, has the largest first ionization energy?

A) Na B) Li C) S D) P

11. Given the four diatomic molecules, HF, HCl, HBr and HI, the expected ordering of bond energies is;

	HF	HCl	HBr	HI
A)	567 kJ	431 kJ	366 kJ	299 kJ
B)	299 kJ	567 kJ	431 kJ	366 kJ
C)	366 kJ	299 kJ	567 kJ	431 kJ
D)	299 kJ	366 kJ	431 kJ	567 kJ

12. The ΔH° for the reaction

$$2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$$

is –670 kJ. Estimate the bond energy for NO.

A) 90 kJ
B) 163 kJ
C) 327 kJ
D) 626 kJ

13. Below are the first four ionization energies for four atoms. Which is most likely to form a 3+ oxidation state?

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

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)

Useful Information

$E_n = -2.18 \times 10^{-18}\ J \left(\frac{1}{n^2}\right)$ $r_n = 0.529 \times 10^{-8}\ n^2\ cm$ $\Delta E = -2.18 \times 10^{-18}\ J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$\lambda = \frac{c}{\nu}$ $E = h\nu$ $c = 3.00 \times 10^8\ \frac{m}{s}$ $h = 6.626 \times 10^{-34}\ J \cdot s$

$\Delta H_{rxn} = \Delta H_{bond\ breakage} + \Delta H_{bond\ formation}$

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

	Bond Energy (kJ/mol)
H–H	435
H–Cl	431
H–C	414
H–O	463
C–C	331
C=C	590
C≡C	812
C–O	326
C=O	803
C≡O	1075
N≡N	941
O_2	495
Cl–Cl	243
S=O	523