

CHEM 1314.02 and 1314.03  
Exam III  
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November 15, 2000

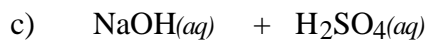
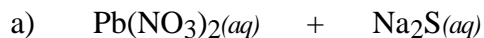
Name \_\_\_\_\_  
TA's Name \_\_\_\_\_  
Lab Section \_\_\_\_\_

### INSTRUCTIONS:

1. This examination consists of a total of 9 different pages. The last three pages include a periodic table, some useful equations, a table of standard heats of formation 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 problems 3, 4a, 4b, 4c, and 5.
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	<u>        </u> (26)	<u>        </u> (20)	<u>        </u> (27)	<u>        </u> (27)	<u>        </u> (100)

(12) 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



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

1c)

Ionic equation:

Net Ionic equation:

(10) 3. A piece of aluminum with a mass of 225 g at a temperature of 98.00 °C is added to a coffee-cup calorimeter containing 75.0 g of water at 24.5 °C. The heat capacity of the calorimeter is 10.5 J °C<sup>-1</sup>. Determine the final temperature of the system. Note: The specific heat of aluminum is 0.900 J g<sup>-1</sup> °C<sup>-1</sup>.

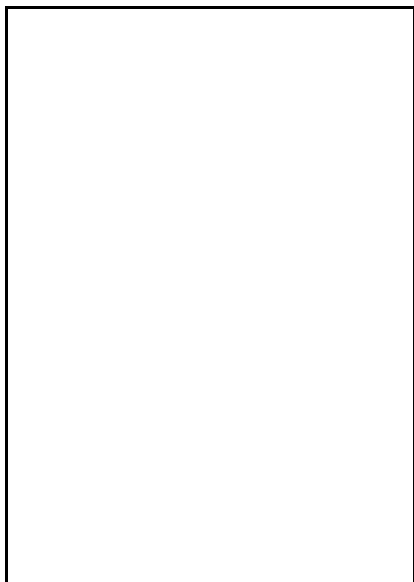
(20) 4. A hydrogen atom emits a photon of light with a wavelength of  $1.875 \times 10^{-6}$  m.

a) Calculate the frequency of this photon.

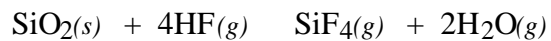
b) Calculate the energy of the photon.

c) Determine the initial energy level of the electron if the final energy level the electron has is  $n = 3$ .

d) Draw and label an energy level diagram for the hydrogen atom and show the transition for the electron as determined in c.



(10) 5. Calculate  $\Delta H^\circ$  for the following reaction,



(12) 6. Write the electron configuration and indicate the number of unpaired electrons for each of the following in their ground state,

i. Cr \_\_\_\_\_ unpaired electrons

ii.  $\text{I}^-$  \_\_\_\_\_ unpaired electrons

iii. Es \_\_\_\_\_ unpaired electrons

(5) 7. Draw the orbital diagram for the valence electrons for phosphorus in its ground state

Multiple Choice: (27 points)

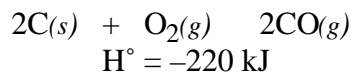
Print the letter (A, B, C, D) which corresponds to the answer selected.

8. \_\_\_\_\_ 9. \_\_\_\_\_ 10. \_\_\_\_\_ 11. \_\_\_\_\_ 12. \_\_\_\_\_  
 13. \_\_\_\_\_ 14. \_\_\_\_\_ 15. \_\_\_\_\_ 16. \_\_\_\_\_

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

8. Which of these species has a standard enthalpy of formation equal to zero?  
 A)  $F_2(g)$                       B)  $F(g)$                       C)  $HF(aq)$                       D)  $F^-(aq)$
9. Which electron configuration is not allowed for either a neutral atom or an ion in its ground state?  
 A)  $1s^2 2s^2 2p^3$   
 B)  $1s^2 2s^1 2p^6$   
 C)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$   
 D)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$
10. Which principal quantum number transition in a hydrogen atom will release the greatest amount of energy?  
 A) 1    3  
 B) 6    4  
 C) 3    5  
 D) 4    2
11. Which element in its ground state has the greatest number of unpaired electrons?  
 A) V (atomic number 23)  
 B) Fe (atomic number 26)  
 C) In (atomic number 49)  
 D) As (atomic number 33)
12. In a bomb calorimeter, reactions are carried out at  
 A) constant volume  
 B) constant pressure  
 C) constant temperature  
 D) 1 atm pressure and 0 °C
13. Which is a possible set of quantum numbers for a valence electron in phosphorus?
- |    | n | l | $m_l$ | $m_s$ |
|----|---|---|-------|-------|
| A) | 2 | 1 | 0     | +1/2  |
| B) | 3 | 0 | 0     | 0     |
| C) | 3 | 1 | -1    | +1/2  |
| D) | 3 | 2 | 1     | -1/2  |

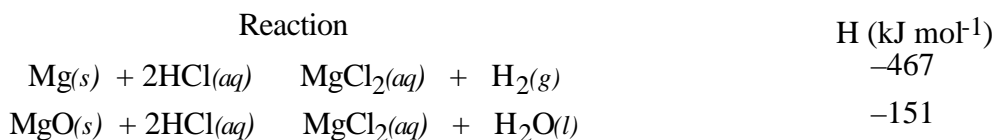
14. Carbon reacts with oxygen according to this equation



- I. The reaction is exothermic  
 II.  $\Delta H_f^\circ$  of CO is  $-220 \text{ kJ}$   
 III. The combustion of  $0.5 \text{ mol}$  of carbon produces  $55 \text{ kJ}$  of heat energy

- A) I only  
 B) I and II  
 C) I and III  
 D) I, II and III

15. Given the reactions



and the  $\Delta H_f^\circ$  for  $\text{H}_2\text{O}(l)$  is  $-286 \text{ kJ mol}^{-1}$ , the  $\Delta H_f^\circ$  for  $\text{MgO}$  is,

- A)  $-904 \text{ kJ}$   
 B)  $-602 \text{ kJ}$   
 C)  $-316 \text{ kJ}$   
 D)  $-30.0 \text{ kJ}$

16. Which of the following processes/reactions is not exothermic?

- A)  $\text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$   
 B)  $2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g)$   
 C)  $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$   
 D)  $\text{SO}_2(s) \rightarrow \text{SO}_2(l)$

## Periodic Table of the Elements

	IA																VIIIA	
1	1 <b>H</b> 1.008																	2 <b>He</b> 4.00
2	3 <b>Li</b> 6.94	4 <b>Be</b> 9.01										5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18	
3	11 <b>Na</b> 22.99	12 <b>Mg</b> 24.30										13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.06	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95	
4	19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.88	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.38	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.59	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
5	37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.1	45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.4	47 <b>Ag</b> 107.9	48 <b>Cd</b> 112.4	49 <b>In</b> 114.8	50 <b>Sn</b> 118.7	51 <b>Sb</b> 121.8	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.3
6	55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 180.9	74 <b>W</b> 183.8	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209.0	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
7	87 <b>Fr</b> (223)	88 <b>Ra</b> 226.0	89 <b>Ac</b> 227.0	104 (261)	105 (262)	106 (263)												

Lanthanides	58 <b>Ce</b> 140.1	59 <b>Pr</b> 140.9	60 <b>Nd</b> 144.2	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.4	63 <b>Eu</b> 152.0	64 <b>Gd</b> 157.2	65 <b>Tb</b> 158.9	66 <b>Dy</b> 162.5	67 <b>Ho</b> 164.9	68 <b>Er</b> 167.3	69 <b>Tm</b> 168.9	70 <b>Yb</b> 173.0	71 <b>Lu</b> 175.0
Actinides	90 <b>Th</b> 232.0	91 <b>Pa</b> 231.0	92 <b>U</b> 238.0	93 <b>Np</b> 237.0	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)

## Useful Information

$$E_n = -2.18 \times 10^{-18} \text{ J} \frac{1}{n^2} \quad r_n = 0.529 \times 10^{-8} \text{ n}^2 \text{ cm} \quad h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$E = -2.18 \times 10^{-18} \text{ J} \left( \frac{1}{n_f} - \frac{1}{n_i} \right) = \frac{c}{\lambda} \quad E = h\nu \quad c = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$$

$$\text{Specific heat of H}_2\text{O}(s) = 2.09 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}} \quad \text{Specific heat of H}_2\text{O}(l) = 4.184 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}}$$

$$\text{Specific heat of H}_2\text{O}(g) = 1.84 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}} \quad \text{Heat of fusion of H}_2\text{O}(s) = 6.01 \frac{\text{kJ}}{\text{mol}}$$

$$\text{Heat of vaporization of H}_2\text{O}(l) = 40.67 \frac{\text{kJ}}{\text{mol}}$$

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

$$H = E + nRT$$

$$q(\text{heat flow}) = \text{mass} \cdot \text{specific heat} \cdot \Delta T$$

$$q_{\text{reaction}} = -(q_{\text{calorimeter}} + q_{\text{solution}})$$

$$q_{\text{reaction}} = -(q_{\text{calorimeter}} + q_{\text{water}})$$

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

Table of Standard Heats of Formation

Substance and State	$H_f^\circ$ (kJ/mol)	Substance and State	$H_f^\circ$ (kJ/mol)
C(s) (graphite)	0	HNO <sub>3</sub> (aq)	-207.36
C(s) (diamond)	2	HNO <sub>3</sub> (l)	-174.10
		HCl(g)	-92.3
CH <sub>4</sub> (g)	-75	HBr(g)	-36.4
CH <sub>3</sub> OH(g)	-201	HI(g)	26.5
CH <sub>3</sub> OH(l)	-239	I <sub>2</sub> (g)	62.25
H <sub>2</sub> CO(g)	-116	O <sub>2</sub> (g)	0
CCl <sub>4</sub> (l)	-135.4	O(g)	249
HCOOH(g)	-363	O <sub>3</sub> (g)	143
HCN(g)	135.1		
CS <sub>2</sub> (g)	117.4	N <sub>2</sub> (g)	0
CS <sub>2</sub> (l)	89.7	NH <sub>3</sub> (g)	-46
C <sub>2</sub> H <sub>2</sub> (g)	227	NH <sub>3</sub> (aq)	-80
C <sub>2</sub> H <sub>4</sub> (g)	52	NH <sub>4</sub> <sup>+</sup> (aq)	-132
CH <sub>3</sub> CHO(g)	-166	N <sub>2</sub> H <sub>3</sub> CH <sub>3</sub> (l)	54
C <sub>2</sub> H <sub>5</sub> OH(l)	-278	N <sub>2</sub> H <sub>4</sub> (l)	50.6
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> N(g)	-533	NO(g)	90.25
C <sub>2</sub> H <sub>6</sub> (g)	-84.7	NO <sub>2</sub> (g)	33.18
C <sub>3</sub> H <sub>6</sub> (g)	20.9	N <sub>2</sub> O(g)	82.0
C <sub>3</sub> H <sub>8</sub> (g)	-104	N <sub>2</sub> O <sub>4</sub> (g)	9.16
C <sub>4</sub> H <sub>10</sub> (g)	-126	N <sub>2</sub> O <sub>4</sub> (l)	20
CH <sub>2</sub> = CHCN(l)	152		
CH <sub>3</sub> COOH(l)	-484	S <sub>2</sub> Cl <sub>2</sub> (g)	-18
C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> (s)	-1275	SO <sub>2</sub> (g)	-296.83
TiO <sub>2</sub> (s)	-945	H <sub>2</sub> S(g)	-20.6
Cl <sub>2</sub> (g)	0	SOCl <sub>2</sub> (g)	-213
Cl <sub>2</sub> (aq)	-23		
Cl <sup>-</sup> (aq)	-167	SiCl <sub>4</sub> (g)	-657
		SiO <sub>2</sub> (s)	-910.94
		SiF <sub>4</sub> (g)	-1614.9
		HF(g)	-273
H(g)	217	TiO <sub>2</sub> (s)	-944.7
H <sup>+</sup> (aq)	0	TiCl <sub>4</sub> (g)	-763
OH <sup>-</sup> (aq)	-230		
H <sub>2</sub> O(l)	-286	ZnO(s)	-348
H <sub>2</sub> O(g)	-242	ZnS(s)	-206



## Solubility Table

<u>Ion</u>	<u>Solubility</u>	<u>Exceptions</u>
$\text{NO}_3^-$	soluble	none
$\text{ClO}_4^-$	soluble	none
$\text{Cl}^-$	soluble	except $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , $\text{*Pb}^{2+}$
$\text{I}^-$	soluble	except $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , $\text{Pb}^{2+}$
$\text{SO}_4^{2-}$	soluble	except $\text{Ca}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Hg}^{2+}$ , $\text{Pb}^{2+}$ , $\text{Ag}^+$
$\text{CO}_3^{2-}$	insoluble	except Group IA and $\text{NH}_4^+$
$\text{PO}_4^{3-}$	insoluble	except Group IA and $\text{NH}_4^+$
$\text{-OH}$	insoluble	except Group IA, $\text{*Ca}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Sr}^{2+}$
$\text{S}^{2-}$	insoluble	except Group IA, IIA and $\text{NH}_4^+$
$\text{Na}^+$	soluble	none
$\text{NH}_4^+$	soluble	none
$\text{K}^+$	soluble	none

\*slightly soluble