

CHEM 1314.05  
Exam II  
John II. Gelder  
October 18, 1994

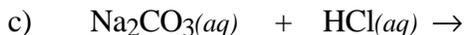
Name \_\_\_\_\_  
TA's Name \_\_\_\_\_  
Lab Section \_\_\_\_\_

### 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 enthalpy's of formation 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 3 – 9.
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	<u>(31)</u>	<u>(20)</u>	<u>(22)</u>	<u>(12)</u>	<u>(15)</u>	<u>(100)</u>

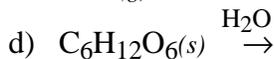
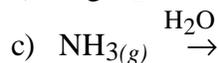
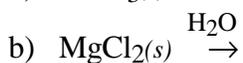
(9) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous.



(12) 2. Identify the species and/or ions formed when each of the compounds below are added to water by writing the chemical equation which describes what occurs. Also indicate whether the compound is a strong, weak or nonelectrolyte. If the compound does not dissolve write WND (will not dissolve).



Type of Electrolyte



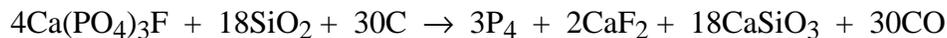
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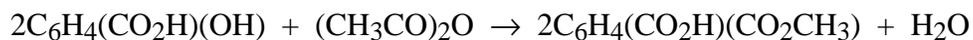
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(10) 3. The following equation shows a reaction for the preparation of elemental phosphorus, P<sub>4</sub>.



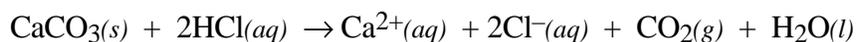
What mass of SiO<sub>2</sub> is required to completely react with 602 grams of Ca(PO<sub>4</sub>)<sub>3</sub>F?

- (10) 4. Aspirin,  $C_6H_4(CO_2H)(CO_2CH_3)$ , is prepared by reacting salicylic acid,  $C_6H_4(CO_2H)(OH)$ , with acetic anhydride,  $(CH_3CO)_2O$ . The reaction is,

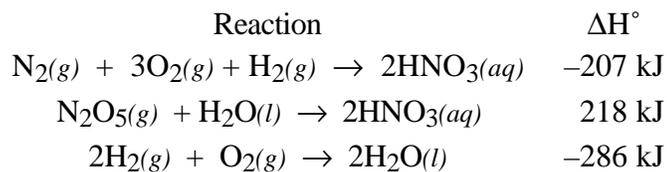


What is the maximum number of grams of aspirin which can be obtained when 75.0 g of salicylic acid is reacted with 35.0 g of acetic anhydride?

- (10) 5. Calculate the volume of 1.50 M HCl which will completely react with 32.0 grams of  $CaCO_3$ . The equation which describes the reaction is,

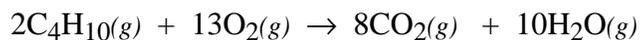


- (10) 6. Using the following standard enthalpy of reaction data and Hess' Law determine the enthalpy of formation for  $\text{N}_2\text{O}_5(g)$ .



Clearly demonstrate how the given equations are to be manipulated to obtain the final equation.

- (12)7a. Disposable lighters use butane as their fuel. Calculate the enthalpy for the combustion of butane as described in the following reaction.



- b) How much heat is released when 0.0500 grams of  $\text{C}_4\text{H}_{10}(g)$  are combusted in excess oxygen?

- (8) 8. The heat of combustion ( $\Delta H^\circ_{\text{combustion}}$ ) of benzene,  $\text{C}_6\text{H}_6(l)$ , is  $-3268 \frac{\text{kJ}}{\text{mol}}$ . If 1.00 g of benzene is combusted and the heat produced from the combustion is absorbed by 100. g of water initially at 20.0 °C, calculate the final temperature of water. Assume no heat is absorbed by the container or the surrounding. (Note: You may wish to provide a brief statement supporting your conclusion.)

- (4) 9. Describe how you would prepare exactly 250.0 mLs of a 6.00 molar solution of sodium hydroxide.

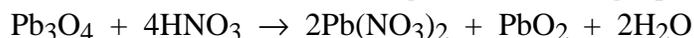
Multiple Choice: (15 points)

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

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 3 points.

10. A form of lead oxide reacts with nitric acid according to the following equation



When 5.25 grams of  $\text{Pb}_3\text{O}_4$  reacts with 200. mLs of 1.00 M  $\text{HNO}_3$ , 3.19 gram of  $\text{Pb}(\text{NO}_3)_2$  are recovered. What is the percent yield of the lead (II) nitrate?

- A) 39.8%                      B) 62.9%                      C) 96.6%                      D) 100%

11. 100. mLs of 0.500 M  $\text{HCl}$  are mixed with 50.0 mLs of 0.350 M  $\text{NaOH}$ . Which of the following statements is true?

- A) The final concentration of unreacted  $\text{NaOH}$  is 0.217 M.  
 B) The final concentration of  $\text{Cl}^-$  is 0.500 M.  
 C) The final concentration of  $\text{Na}^+$  is 0.117 M.  
 D) The final concentration of  $\text{H}^+$  is 0.0325 M.

12. The percent composition of a hydrated compound containing Na, S, O and water is,

Component	Percent
Na	14.27
S	9.951
O	19.86
$\text{H}_2\text{O}$	55.92

The empirical formula of the hydrate is

- A)  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$   
 B)  $\text{Na}_2\text{SO}_3 \cdot 5\text{H}_2\text{O}$   
 C)  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 9\text{H}_2\text{O}$   
 D)  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$

13. Which of the following reactions would you expect to be endothermic?

- A)  $2\text{Na}(s) + 2\text{H}_2\text{O}(l) \rightarrow 2\text{Na}^+(aq) + 2\text{OH}^-(aq) + \text{H}_2(g)$   
 B)  $4\text{Na}(s) + \text{O}_2(g) \rightarrow 2\text{Na}_2\text{O}(s)$   
 C)  $2\text{NaCl}(s) \rightarrow 2\text{Na}(s) + \text{Cl}_2(g)$   
 D)  $2\text{NaH}(s) \rightarrow 2\text{Na}(s) + \text{H}_2(g)$

14. Which one of the following samples would require the least amount of thermal energy (heat) to bring its temperature to  $80^\circ\text{C}$ ?

- A) 200 g  $\text{H}_2\text{O}(l)$  at  $40^\circ\text{C}$   
 B) 100 g  $\text{H}_2\text{O}(l)$  at  $20^\circ\text{C}$   
 C) 200 g  $\text{H}_2\text{O}(l)$  at  $20^\circ\text{C}$   
 D) 100 g  $\text{H}_2\text{O}(l)$  at  $40^\circ\text{C}$

## 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

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

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

$$\text{Specific heat of H}_2\text{O}(g) = 1.84 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}}$$

$$\text{Heat of fusion of H}_2\text{O}(s) = 6.01 \frac{\text{kJ}}{\text{mol}}$$

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

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

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

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

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

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

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

## 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

Table of Standard Heats of Formation

Substance and State	$\Delta H_f^\circ$ (kJ/mol)	Substance and State	$\Delta H_f^\circ$ (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 <sub>2</sub> (g)	-393.5	I <sub>2</sub> (g)	62.25
CH <sub>4</sub> (g)	-75	O <sub>2</sub> (g)	0
CH <sub>3</sub> OH(g)	-201	O(g)	249
CH <sub>3</sub> OH(l)	-239	O <sub>3</sub> (g)	143
H <sub>2</sub> CO(g)	-116		
CCl <sub>4</sub> (l)	-135.4	N <sub>2</sub> (g)	0
HCOOH(g)	-363	NH <sub>3</sub> (g)	-46
HCN(g)	135.1	NH <sub>3</sub> (aq)	-80
CS <sub>2</sub> (g)	117.4	NH <sub>4</sub> <sup>+</sup> (aq)	-132
CS <sub>2</sub> (l)	89.7	N <sub>2</sub> H <sub>3</sub> CH <sub>3</sub> (l)	54
C <sub>2</sub> H <sub>2</sub> (g)	227	N <sub>2</sub> H <sub>4</sub> (l)	50.6
C <sub>2</sub> H <sub>4</sub> (g)	52	NO(g)	90.25
CH <sub>3</sub> CHO(g)	-166	NO <sub>2</sub> (g)	33.18
C <sub>2</sub> H <sub>5</sub> OH(l)	-278	N <sub>2</sub> O(g)	82.0
C <sub>2</sub> H <sub>5</sub> O <sub>2</sub> N(g)	-533	N <sub>2</sub> O <sub>4</sub> (g)	9.16
C <sub>2</sub> H <sub>6</sub> (g)	-84.7	N <sub>2</sub> O <sub>4</sub> (l)	20
C <sub>3</sub> H <sub>6</sub> (g)	20.9	HNO <sub>3</sub> (aq)	-207.36
C <sub>3</sub> H <sub>8</sub> (g)	-104	HNO <sub>3</sub> (l)	-174.10
C <sub>4</sub> H <sub>10</sub> (g)	-126	NH <sub>4</sub> ClO <sub>4</sub> (s)	-295
CH <sub>2</sub> = CHCN(l)	152		
CH <sub>3</sub> COOH(l)	-484		
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	S <sub>2</sub> Cl <sub>2</sub> (g)	-18
Cl <sup>-</sup> (aq)	-167		
		SiO <sub>2</sub> (s)	-910.94
H <sub>2</sub> (g)	0	SiF <sub>4</sub> (g)	-1614.9
H(g)	217	SiCl <sub>4</sub> (g)	-657
H <sup>+</sup> (aq)	0		
OH <sup>-</sup> (aq)	-230	TiCl <sub>4</sub> (g)	-763
H <sub>2</sub> O(l)	-286	TiO <sub>2</sub> (s)	-944.7
H <sub>2</sub> O(g)	-242		