Chemistry 103-2
Fall 1998
Examination II

Name _____
Section_____**TA**_____

INSTRUCTIONS

1. This exam consists of 9 pages, a page of thermodynamic data, a page of useful information and equations, and a periodic table. If a page is missing, take the exam to a proctor immediately.

2. PRINT your name NOW in the spaces at the top of ALL pages.

3. Part A is worth 30 points. Part B is worth 51 points. Part C is worth 19 points.

4. The exam should be easy to complete in 75 minutes. Check your work after completing the exam. **Please show all your work and be certain that all your explanations are given as complete sentences.**

5. On the grading chart at the bottom of this page, CIRCLE the numbers of the questions you would like to be graded. Check that you have circled the correct number of questions for Parts A (2), B (3) and C (1).

Honor Code: *By the definition of academic integrity, the exam I am handing in is solely my own work and truthfully represents work I have done.*

_____
Signature

Part A	**1**		**/15 pts.**
	2		**/15 pts.**
	3		**/15 pts.**
	4		**/15 pts.**
Part B	**5**		**/17 pts.**
	6		**/17 pts.**
	7		**/17 pts.**
	8		**/17 pts.**
	9		**/17 pts.**
	10		**/17 pts.**
Part C	**11**		**/19 pts.**
	12		**/19 pts.**
TOTAL			**/100 pts.**

Name _____

PART A. (30 points) **BASIC QUESTIONS.** Answer TWO of the following four questions. Write your answer in the space provided. SHOW YOUR WORK AND WRITE EXPLANATIONS IN FULL SENTENCES.

1. The following questions refer to the reaction below. In parts a) and b), circle the correct answer.

$$N_2\,(g) + O_2\,(g) \text{ ------> } 2\,NO\,(g) \quad \Delta H° = 181.8\ kJ$$

a) This reaction is **exothermic / endothermic**.

b) Heat is **released / absorbed** by the chemicals in this reaction.

c) Write the reaction for which the enthalpy is the standard heat of formation of NO and calculate $\Delta H°_f$.

d) Calculate the amount of heat transferred when 300. g of N_2 are reacted with excess O_2.

2. In the following reaction identify the oxidant and the reductant and give the oxidation numbers of the indicated atoms in the reactants and the products.

$$Fe\,(s) + Ni(NO_3)_2\,(aq) \text{ ---------> } Fe(NO_3)_2\,(aq) + Ni\,(s)$$

oxidant_____

reductant_____

Fe	reactants_____	products_____
Ni	reactants_____	products_____
N	reactants_____	products_____
O	reactants_____	products_____

Name _____

3. The emission spectrum of hydrogen consists of four lines in the visible wavelengths at 656.3 nm, 486.1 nm, 434.1 nm and 410.2 nm. Calculate the value in parts a-c) and circle the correct phrase in part d).

a) The lowest energy line is at _____nm.

b) The frequency of this line is _____ s^{-1}.

c) The energy of this line is _____ J.

d) Energy is absorbed in the form of light when electrons move from: **higher energy states to lower energy states / lower energy states to higher energy states.**

4. How many grams of potassium nitrate are needed to make 500.00 mL of a 0.155 M aqueous solution?

_____ g

Name _____

Part B (51 points) **COMPETENCY QUESTIONS** Answer THREE of the following six questions in the space provided. SHOW YOUR WORK AND WRITE EXPLANATIONS IN FULL SENTENCES.

5. A 25.00 mL calcium hydroxide solution of unknown concentration was titrated with 0.2500 M hydrochloric acid. It required 37.52 mL of acid to reach the endpoint. What was the concentration of the calcium hydroxide solution?

6. What mass of precipitate is produced when 35.0 mL of 0.136 M $AgNO_3$ is combined with 18.0 mL 0.255 M KBr?

Name _____

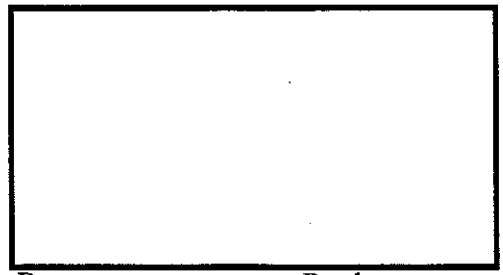
7. a) Using the thermochemical data provided at the end of this exam, calculate $\Delta H°_{rxn}$ for the combustion of 1 mol of propane. The balanced reaction for this process is given below.

$C_3H_8\,(g) + 5\,O_2\,(g) \rightarrow 3\,CO_2\,(g) + 4\,H_2O\,(g)$ $\Delta H°_{rxn}$=_____ kJ/mol

b) Use the information below to calculate $\Delta H°_{rxn}$ for the combustion of propane to produce liquid water instead of gaseous water.

$H_2O\,(l) \rightarrow H_2O\,(g)$ $\Delta H°_{rxn}$= 44 kJ/mol

8. Write a balanced chemical equation, including states, for the reaction of aqueous iron (III) nitrate with aqueous sodium hydroxide. In the box below make a two-dimensional drawing of the submicroscopic particles of the reactants and products in the reaction. Include six water molecules in your drawing.



Name _____

9. a) Three sets of possible quantum numbers for an electron in a hydrogen atom are given below. Identify the two impossible sets and explain why each is unreasonable.

1) $n = 2, l = 3, m_l = -3$
2) $n = 3, l = 1, m_l = 2$
3) $n = 2, l = 1, m_l = 0$

b) Draw a picture of an orbital designated by the quantum numbers $n = 3, l = 1, m_l = -1$.

c) Explain, in words and a picture, how the orbital you drew in part b would differ if $n = 2$ and the other quantum numbers remained the same.

Name _____

10. Cobalt (II) carbonate reacts with aqueous hydrobromic acid.

a) Write the balanced overall reaction for this process.

b) Write the total (complete) ionic equation for this process. Identify the spectator ions if any are present.

c) Write the net ionic equation for this process.

d) What type of reaction is this? Explain how you arrived at your conclusion identifying those species characteristic of the reaction type (i.e. identify the acid and base in an acid/base reaction, the precipitate for a precipitation reaction, the gas formed in a gas forming reaction, and the oxidant and reductant in an oxidation/reduction reaction.) Note that a reaction may be of more than one type.

Name _____

Part C (19 points) **MASTERY QUESTIONS** Answer ONE of the following two questions in the space provided. SHOW ALL YOUR WORK AND WRITE EXPLANATIONS IN COMPLETE SENTENCES.

11. The following questions refer to the balanced thermochemical equation given below.

$CuSO_4\,(aq) + 2\,KOH\,(aq) \rightarrow Cu(OH)_2\,(s) + K_2SO_4\,(aq) \qquad \Delta H = -52.1\ kJ$

a) In a coffee cup calorimeter, 55.0 mL of 1.26 M $CuSO_4$ was reacted with 43.5 mL 2.53 M KOH. The chemicals were initially at 23.2°C. What was the final temperature measured when the reaction was complete? (Assume that the solutions have the properties of pure water, i.e a density of 1.0 g/mL and a specific heat capacity of 4.2 J/g°C.)

b) How many moles of $CuSO_4$ must react with excess KOH to melt an 18.0 g ice cube at 0°C? The heat of fusion of water is 6.00 kJ/mol.

Name _____

12. You walk into the laboratory and your TA hands you four clear colorless solutions in unmarked test tubes. She tells you that she is certain that one solution is $NaHCO_3$, the second is NaOH, the third is $ZnCl_2$, and the fourth is NaBr. Describe how you would determine which solution is which. Assume that you have available all the laboratory equipment that you have used in the laboratory and access to whatever chemicals you need. You may use process of elimination, but you must describe one experiment to positively identify each solution. Write a balanced chemical equation for each reaction you run.

Table 6.2 • Selected Standard Molar Enthalpies of Formation at 298 K

Substance	Name	Standard Molar Enthalpy of Formation (kJ/mol)
$Al_2O_3(s)$	aluminum oxide	−1675.7
$BaCO_3(s)$	barium carbonate	−1216.3
$CaCO_3(s)$	calcium carbonate	−1206.9
$CaO(s)$	calcium oxide	−635.1
$CCl_4(\ell)$	carbon tetrachloride	−135.4
$CH_4(g)$	methane	−74.8
$CH_3OH(\ell)$	methanol	−238.7
$C_2H_5OH(\ell)$	ethanol	−277.7
$CO(g)$	carbon monoxide	−110.5
$CO_2(g)$	carbon dioxide	−393.5
$C_2H_2(g)$	ethyne (acetylene)	+226.7
$C_2H_4(g)$	ethene (ethylene)	+52.3
$C_2H_6(g)$	ethane	−84.7
$C_3H_8(g)$	propane	−103.8
$C_4H_{10}(g)$	butane	−125.6
$CuSO_4(s)$	copper(II) sulfate	−771.4
$H_2O(g)$	water vapor	−241.8
$H_2O(\ell)$	liquid water	−285.8
$HF(g)$	hydrogen fluoride	−271.1
$HCl(g)$	hydrogen chloride	−92.3
$HBr(g)$	hydrogen bromide	−36.4
$HI(g)$	hydrogen iodide	+26.5
$KF(s)$	potassium fluoride	−567.3
$KCl(s)$	potassium chloride	−436.7
$KBr(s)$	potassium bromide	−393.8
$MgO(s)$	magnesium oxide	−601.7
$MgSO_4(s)$	magnesium sulfate	−1284.9
$Mg(OH)_2(s)$	magnesium hydroxide	−924.5
$NaF(s)$	sodium fluoride	−573.6
$NaCl(s)$	sodium chloride	−411.2
$NaBr(s)$	sodium bromide	−361.1
$NaI(s)$	sodium iodide	−287.8
$NH_3(g)$	ammonia	−46.1
$NO(g)$	nitrogen monoxide	+90.3
$NO_2(g)$	nitrogen dioxide	+33.2
$PCl_3(\ell)$	phosphorus trichloride	−319.7
$PCl_5(s)$	phosphorus pentachloride	−443.5
$SiO_2(s)$	silicon dioxide (quartz)	−910.9
$SnCl_2(s)$	tin(II) chloride	−325.1
$SnCl_4(\ell)$	tin(IV) chloride	−511.3
$SO_2(g)$	sulfur dioxide	−296.8
$SO_3(g)$	sulfur trioxide	−395.7

Source: From http://webbook.nist.gov/

Useful Equations

$d = \frac{m}{V}$ $\quad PV = nRT$ $\quad$ STP 0°C, 1 atm

$P_{tot} = P_1 + P_2 + P_3 \ldots$ $\quad \chi_1 = \frac{n_1}{n_{tot}} = \frac{P_1}{P_{tot}}$

$u_{rms} = \sqrt{\frac{3RT}{MW}}$ $\quad \left(P - \frac{n^2a}{V^2}\right)\left(V - nb\right) = nRT$

$\Delta H°_{rxn} = \sum[\Delta H°_f(\text{products})] - \sum[\Delta H°_f(\text{reactants})]$ $\quad P_1 = x_1 P°_1$

$c = \lambda\nu$ $\quad E = \frac{hc}{\lambda} = h\nu$ $\quad q = mC\Delta T$

$P = \frac{2}{3}\left[\frac{nN_A(\frac{1}{2}mu^2)}{V}\right]$ $\quad \Delta T_{f,b} = K_{f,b} m_{solute} i$ (where i = moles of particles)

B.O. = ½ (bonding e⁻s – antibonding e⁻s)

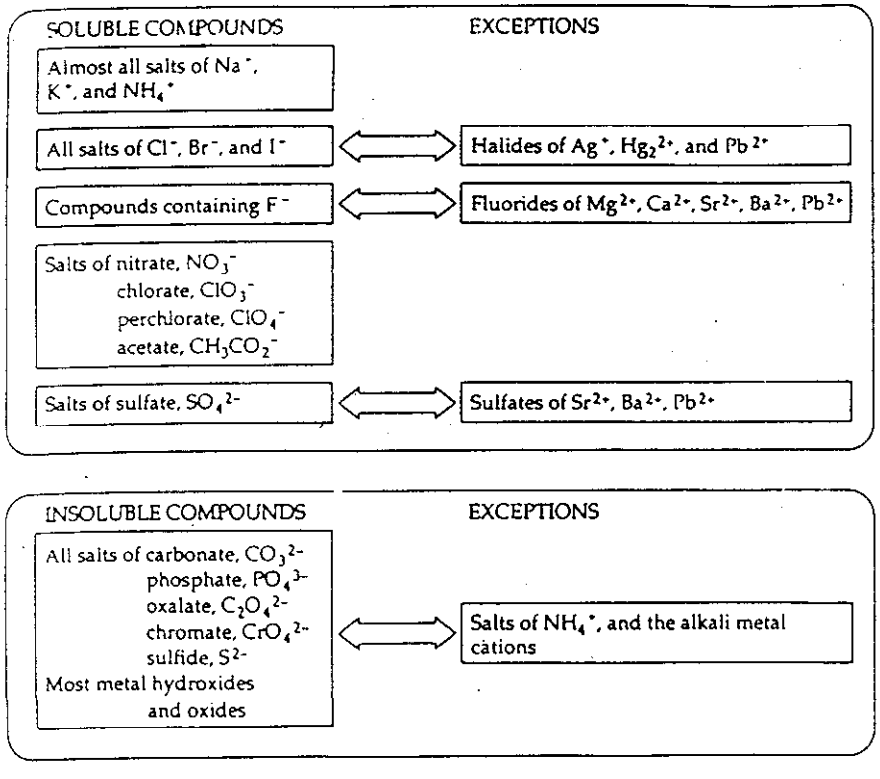


Figure 4.7 Guidelines to predict the solubility of ionic compounds. If a compound contains *one of the ions* in the column on the left in the top chart, the compound is predicted to be at least moderately soluble in water. There are a few exceptions, and those are noted at the right. Poorly soluble ionic compounds are usually formed by the anions listed at the bottom of the chart, with the exceptions of compounds with NH_4^+ and the alkali metal cations.