CHEMISTRY 1127 **EXAM III** **December 2, 2011**

NAME (PRINT) _____ SECTION_____

SIGNATURE _____ TA _____

PLEASE READ THE FOLLOWING INSTRUCTIONS

Do NOT begin the exam until asked to do so.

There are 10 numbered pages, a useful information page and a periodic table in this exam. Check to see that they are all here before you begin the exam. Return all these papers when you are finished. Write your name on every page. Use a **pen** with blue or black ink for the entire exam.

Exams done in pencil, erasable ink, or where white-out, liquid paper, etc. have been used are *ineligible for regrades*.

Be sure to follow the directions in answering all questions. Write your final answers in the blanks provided. In working problems, you must **SHOW ALL WORK**. No credit will be given unless all work is clearly shown and the method of solution is logically correct. Use correct units and significant figures.

Do not write below this line

Page	Total	Grader
1	_____ / 30	
2	_____ / 24	
3	_____ / 24	
4	_____ / 12	
5	_____ / 18	
6	_____ / 10	
7	_____ / 14	
8	_____ / 8	
9	_____ / 10	
10		

Total Grade _____ /150 Checked by _____

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December 2, 2011

I. (54 points)

A. (10 points) Answer the following questions.

_____ **1.** What is the alkaline earth metal cation that is isoelectronic with xenon?

_____ **2.** Light has particle properties. (**True** or **False**).

_____ **3.** Excited atoms emit light only at discrete, well defined wavelengths. (**True** or **False**).

_____ **4.** As effective nuclear charge increases, atomic radius decreases. (**True** or **False**).

_____ **5.** Electrons have wave properties. (**True** or **False**).

B. (16 points) Place your answer to the following questions in the blank provided.

_____ **a.** What is the element that has the electron configuration $1s^2s^22p^63s^13p^3$?

_____ **b.** Give the abbreviated electron configuration for Fe^{3+}.

_____ **c.** How many unpaired electrons are there in Fe^{3+}?

_____ **d.** Are Zn atoms expected to be diamagnetic or paramagnetic? Why? (No reason no credit.)

_____ **e.** How many electrons with quantum number ℓ = 1 are there in the ground state electron configuration for rubidium?

_____ **f.** How many electrons can have both quantum number n = 4 and m_ℓ = 0?

_____ g. How many orbitals have n = 4?

_____ **h.** Write the symbol of the element in period 3 with the most unpaired electrons.

C. (4 points) Which of the following electron configurations are for atoms in the ground state (GS)? In the excited state (ES)? Which are impossible (IMP)?

_____ **1.** $1s^22s^23s^23f^4$

_____ **2.** $1s^22s^22p^12d^1$

D. (8 points) Carbon monoxide absorbs energy with a frequency of 6.5×10^{10} s^{-1}.
($1 \text{ nm} = 1 \times 10^{-9} \text{ m}$)

1. What is the wavelength (in nm) of the absorption?

_____

2. A sample of CO absorbs 32 kJ of energy. How many photons were absorbed?

_____

E. (4 points) What is the energy difference (in J) for a transition from n = 6 to n = 4 in the hydrogen atom?

_____

F. (6 points) Consider the following atoms: Rb, Sr, Sb, and Cs.

_____ **a.** Which is the *largest*?

_____ **b.** Which has the *lowest* ionization energy?

_____ **c.** Which is the *most* electronegative?

G. (6 points) Select the *smallest* species in each case: CIRCLE your answer

a. P or P^{3-}

b. Co or Co^{2+} or Co^{3+}

c. F^- or Na^+

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II. (40 points)

A. (4 points)

i. Draw reasonable **Lewis structure** for NO_2^+. (Your Lewis structure will not be considered.)

ii. Give the **number of valence electrons**.

iii. Give the **molecular geometry**.

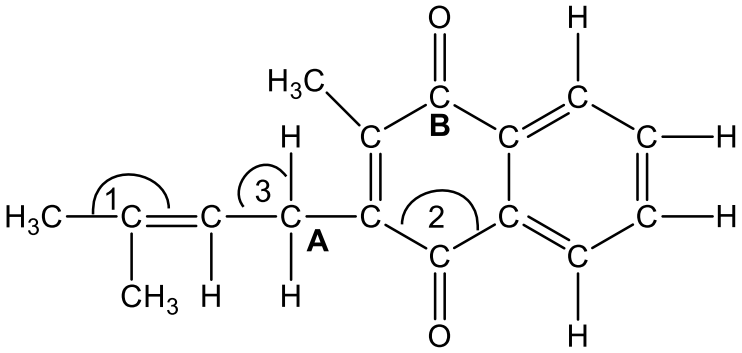
B. (6 points) Draw the Lewis structure for the molecule NO_2Cl and answer the following questions. Your Lewis structure will not be considered.

a. What is the total number of valence electrons in the molecule? _____

b. How many unshared electron pairs are around the central atom? _____

c. What is the bond angle around the central atom? _____

C. (14 points) Consider the skeleton structure shown below (not a Lewis structure).



_____**a.** How many sigma bonds are there in this structure?

_____**b.** How many pi bonds are there in this structure?

_____**c.** What is the approximate value of the angle marked 1?

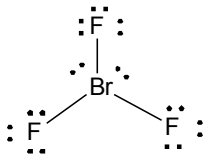
_____**d.** What is the approximate value of the angle marked 2?

_____**e.** What is the approximate value of the angle marked 3?

_____**f.** What is the hybridization of atom A?

_____**g.** What is the hybridization of atom B?

D. (6 points) Given the Lewis structure of the BrF_3, answer the questions on the blanks provided.



_____ **a.** electron pair geometry

_____ **b.** molecular geometry

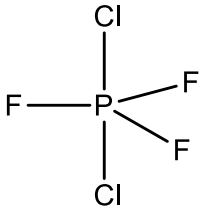
_____ **c.** hybridization of the central atom

_____**d.** Is it polar? (YES or NO)

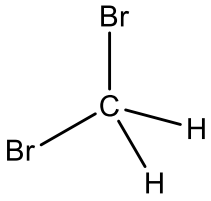
E. (6 points) Circle whichever of the following species that is(are) polar: (molecular geometry is given)

O=C=S

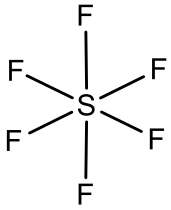
linear



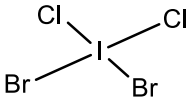
trigonal bipyramid



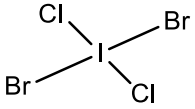
tetrahedral



octahedral



square planar



square planar

III. (42 points)

A. (10 points) Answer the questions below.

_____ **1.** If energy flows out of a system and into the surroundings, what is the sign of ΔH?

_____ **2.** The higher the heat capacity of a system higher the change in temperature for a given amount of heat absorbed. (**True** or **False)**.

_____ **3.** The magnitude of ΔH is independent of the amount of reactant. (**True** or **False)**.

_____ **4.** If the system has a lower enthalpy at the end of the reaction, then it released heat to the surroundings, thus the reaction is endothermic. (**True** or **False)**.

_____ **5.** The heat of fusion for water is +6.00 kJ/mol. The enthalpy for $H_2O(\ell)$ is lower than that for $H_2O(s)$. (**True** or **False)**.

B. (8 points) Isooctane, C_8H_{18}, a component of gasoline, gives off 24.06 kJ of heat when 0.500 g are burned. A 100.0 mg sample of isooctane is burned in a bomb calorimeter that contains 500.0 g of water. The temperature of the bomb and water increases by 1.54°C. (The specific heat of water is 4.18 J/g·°C)

1. How much heat is given off when 100.0 mg isooctane is burned in a bomb calorimeter?

_____

2. What is the heat capacity of the bomb?

_____

C. (10 points) Calculate the amount of heat involved in evaporation of 100.00 g liquid benzene, C_6H_6 (MM = 78.108 g/mol) at 25.00°C to benzene gas at 80.00°C. **(See Useful Information Sheet for pertinent data.)**

1. Calculate ΔH for : C_6H_6 (ℓ, 25.00°C) → C_6H_6 (ℓ, 80.00°C)

_____

2. Calculate ΔH for : C_6H_6 (ℓ, 80.00°C) → C_6H_6 (g, 80.00°C)

_____

3. Calculate ΔH for : C_6H_6 (ℓ, 25.00°C) → C_6H_6 (g, 80.00°C)

_____

D. (8 points) The nitroglycerin ($C_3H_5N_3O_9$) decomposes rapidly upon ignition according to the following equation:

$$4C_3H_5N_3O_9(\ell) \rightarrow 12CO_2(g) + 10H_2O(g) + 6N_2(g) + O_2(g) \qquad \Delta H = -5678 \text{ kJ}$$

$\Delta H_f^\circ(CO_2) = -393.5$ kJ/mol $\qquad \Delta H_f^\circ(H_2O) = -241.8$ kJ/mol

$MM(C_3H_5N_3O_9) = 227.1$ g/mol

1. What is the ΔH for the reaction of 14.2 g of $C_3H_5N_3O_9$?

_____

2. What is enthalpy of formation for $C_3H_5N_3O_9$?

_____

E. (6 points) Calculate the ΔH for the following reaction :

$CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(g) + 4HCl$

Use the following equations and given enthalpy changes:

$C(s) + 2H_2(g) \rightarrow CH_4(g) \qquad \Delta H = -74.6$ kJ

$C(s) + 2Cl_2(g) \rightarrow CCl_4(g) \qquad \Delta H = -95.7$ kJ

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta H = -92.3$ kJ

_____

IV. (18 points)

A. (8 points) Consider the following balanced redox reaction. The reaction is the basis for the permanganate titration used for determine the % Fe in a sample.

$$8H^+(aq) + MnO_4^-(aq) + 5Fe^{2+}(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O$$

3.7 g of an unknown iron salt are dissolved in water, acidified with H_3PO_4 and titrated with a standardized $KMnO_4$ solution. A persistent pink color is observed after 10.5 mL of 0.250 M $KMnO_4$ solution are used.

1. How many moles of MnO_4^- are used in titration?

_____

2. How many moles of Fe are present in the sample?

_____

3. What is the mass percent of Fe in the sample?

_____

B. (10 points) A student analyzed a volatile liquid to determine the molar mass. A flask is weighed and found to have a mass of 53.973 g. To the flask 5 mL of an unknown liquid is added and heated in a 98˚C in a water bath. All the liquid is vaporized; the flask is removed from the bath, stoppered and allowed to cool. All of the vapor condenses and is then weighed, obtaining a mass of 54.668 g. The volume of the flask is known to be 238.98 mL. The barometric pressure in the lab is 738 mm Hg.

1. What is the pressure of the vapor in the flask in atm?

_____

2. How many moles of volatile liquid are in the flask?

_____

3. What is the mass of the vapor present in the flask after analysis?

_____

4. What is the molar mass of the unknown liquid?

_____

BONUS (10 points) All or nothing

The bonus should be done only after you have completed the main part of this exam and checked your work for errors. The time allotted for this exam does not include time for the bonus. (SHOW ALL WORK!) *Trial* and *error solutions will not be accepted* and *method of solution should be logical*.

An ice cube of mass 9.0 g is added to a cup of coffee, whose temperature is 90.0°C and which contains 120.0 g of liquid. Assume the specific heat capacity of the coffee is the same as that of water. The heat of fusion of ice is 6.0 kJ/mol. Find the temperature of the coffee after the ice melts.