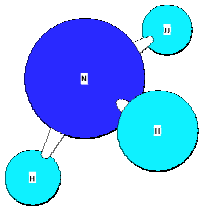
Sample Exam Three CHM 2045C

I. General Knowledge:

1. The energy of sublimation is used to describe what physical process? Write the equation using CO_2 as the substance
2. Write the equation that demonstrates the second ionization of Ca.
3. As you read from left to right in a period, the ionization energy (**increases**, **decreases**, or **stays the same**). This is due to (**increased** or **decreased**) values of (**shielding** or **effective nuclear charge**)
4. The cation of a metal is (**larger** or **smaller**) than its atomic state. This is because of _____



5. (**True** or **False**) Lattice energy is the formation of gaseous ions from an ionic solid.
6. Consider the structure shown at left. What is the hybridization on the central atom?
7. (**True** or **False**) In resonance structures, atoms are rearranged to give the lowest formal charges.
8. List the elements that usually do not obey the octet rule.
9. Bond dissociation energies are average values in the chart. Explain why this is so.
10. A bond is polar if there is a difference in electronegativities. How would the polarity of an ionic bond compare to that of a covalent bond?
11. When a reaction is temperature cpntrolled, what condition exists.
12. What defines a reaction's spontaneity?

II. Born-Haber energetics

13. Draw the Born Haber cycle for NaH , so that you can calculate its lattice energy:
    i. E_{ea} for H= -72.8 kJ/mol
    ii. $E_{i,1}$ fopr Na=495.8 kJ/mol
    iii. $\Delta H_{sublimation}$ for Na= 107.3 kJ/mol
    iv. D-D for H_2= 435.9 kJ/mol
    v. $\Delta H_{reaction}$ for the reaction in which NaH is formed from the elements in their standard states: = -60kJ/mol

II. Lewis structures, VSEPR theory, hybridization, resonance and formal charges

1. Free radical structures are those in which there is an unpaired electron. They are usually not stable. Consider the molecule ClO_2. Draw the Lewis structure(s) and determine the formal charges on each atom.
2. PCl_5 is a common expanded octet molecule. Draw its lewis structure, determine its geometry, and draw its valence bond hybrid structure.
3. $SOCl_2$ has at least 2 resonance structures. Draw 2, and indicate that which is better. Explain your decision. Draw the hybridization diagram. Label all bonds according to whether they are sigma or pi type.

III. Thermochemistry:

for the process: $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

1. Calculate $\Delta H^0_{reaction}$, $\Delta S^0_{reaction}$, Δ at 25^0C.
2. Is the reaction spontaneous at this temperature?

4. Write the reaction that is associated with the $\Delta H^0_{formation}$ of $CaCO_{3(s)}$
5. What quantity of heat is associated with the decomposition of 22g of $CaCO_3$?
6. Is this reaction exothermic or endothermic? Explain your answer.
7. $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$
   In gas phase reactions involving covalent molecules, the reaction enthalpy may be estimated using Bond dissociation energies. For this reaction, the enthalpy of the reaction is –2043 kJ/mol C_3H_8 combusted.
   Given the following Dissociation energies(kJ/mol bond), find the dissociation energy of the C=O bond.
   C-H 410 C-C 350 H-O 460 O=O 498

8. Hess's Law can be used to calculate reaction enthalpies for hypothetical processes that can't be carried out in the laboratory. Set up a Hess's Law cycle that will let you calculate $\Delta H^0_{reaction}$ for the conversion of methane to ethylene:
$2CH_{4(g)} \rightarrow C_2H_{4(g)} + 2H_{2(g)}$

reactions to use:

$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$	$\Delta H^0_1 = -3119.4$ kJ
$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$	$\Delta H^0_2 = -890.3$ kJ
$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$	$\Delta H^0_3 = -890.3$ kJ
$H_{2(g)} + ½\ O_{2(g)} \rightarrow H_2O_{(l)}$	$\Delta H^0_4 = -890.3$ kJ

9. When 0.187 g of benzene, C_6H_6 is burned in a bomb calorimeter, the surrounding water bath rises in temperature by 7.48^0C. Assuming that the bath contains 250.0 g water and that the calorimeter itself absorbs a negligible amount if heat, calculate the combustion enthalpy for benzene in kJ/mol.

Short answer: Explain how a bomb calorimeter differs from coffee cup calorimeter. Include the quantities measured, and the specific application for which it is appropriate.