Chem 35 - Exam I   **October 5, 1999**   **Prof. W.R. Leenstra**

NAME: _____   **Please take a second to read these instructions:**

For all your answers, be concise and precise, and write legibly, so take your time and use plenty of space. Think about how to attack the problem in a coherent manner before you start writing. You must show all of your work and reasoning. Each of the four multiple choice questions in problem 10 (10a-10d) is worth 3 pts.; problem 1 is worth 8 pts. and all others are 10 pts. each. Answer them by circling your choice; don=t leave any question uncircled.
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1.   (a)   The americium isotope ^{241}Am is used in smoke detectors. Describe the composition of a neutral atom of this isotope in terms of protons, neutrons, and electrons

        (b)   This isotope represents 31% of the natural abundance of americium. The isotope ^{244}Am makes up the remainder. What is the mass of one mole of naturally occurring Am.

2.   (a)   The natural process of lightning can produce a Afulgarite@ molecule of composition 46.01% Fe and 53.99% Si. Determine the formula of this molecule (caution: rounding off too early may prevent you from obtaining the correct answer).

        (b)   Circle the answer to the question: What formula have you determined?

                          Molecular   Empirical

3.   (a)   Draw two possible Lewis diagrams for the sulfine molecule whose formula is H_2CSO. The C, S and O atoms are connnected in that order, with the two H atoms attached to the C atom. Use only electron Adots@, but give different symbols to the electrons originating from different atoms.

(b)   Draw one Lewis diagram for H_2CSO, in which the arrangement of atoms has been changed to the following: H, C, S and H atoms connected in that order, with the O atom connected to the C atom.

(c)   Circle the answer to the question: How many of the three structures you have drawn above are resonance structures?

       None   One   Two   Three

(d)   Determine the formal charges on all the atoms for the structure in (b) above, and write your answers in the table below.

Atom	Formal Charge
H	
C	
S	
O	

4. For the following compounds, give the chemical names <u>below</u> their respective formulas (using the Roman numeral notation wherever possible). Indicate the oxidation number of each element <u>above</u> the respective atoms.

$Na_2Cr_2O_7$ $Fe(NO_2)_3$ Cl_2O_7

5. The molecule SF_4 has a central sulfur atom with an expanded valence shell.

   (a) Draw the Lewis diagram for this molecule.

   (b) What is the steric number of the central atom? Indicate your answer below.

        $SN =$

   (c) Of the two possible molecular geometries, determine which one is energetically favored. You need to accompany your answer with the appropriate illustrations and arguments.

6.   (a)   In the diagram below, indicate with an arrow the magnitude of the Coulomb stabilization energy.

      (b)   For the reaction Cs + Br → Cs^+ + Br^-

            calculate the ÄE at infinite separation, using the following information:

Element	Z (at. #)	IE (kJ/mole)	EA (kJ/mole)	÷ (electroneg.)
Cs	55	376	45	0.79
Br	35	1140	325	2.96

7.   With the aid of a graph that has been marked up appropriately with, for example, the labels for the axes, explain in clear, grammatically correct, concise writing how it was determined that absolute zero degrees Kelvin corresponds to -273 degrees Celsius.

8. A sample of **A**pure**@** air was collected in Greenland in a 21.6 L container, at a temperature of -20.0 degrees Celsius and a pressure of 1.01 atm. It is forced into a 1.05 L bottle for shipment to the Netherlands for analysis.

    (a) Compute the pressure inside the collection container just after it is filled .(R = 0.08205 L atm / deg mole)

    (b) Compute the pressure inside the shipment bottle just before it is opened in the laboratory where the temperature is a comfortable 21.0 degrees Celsius.

9. For this problem start with a balanced equation for the reaction of hydrogen gas (H_2) with nitrogen gas (N_2) to produce ammonia (NH_3). If 38.0 g of H_2 are mixed with 420.0 g of N_2, what are the amounts of reactants left and product formed (in grams) when the reaction has run its course to completion?

10. **Multiple Choice** [Circle the correct choice letter.]

10a. The bond length for a carbon-carbon double bond is closest to

    a. 10.5 Å
    b. 1.0 Å
    c. 1.5 Å
    d. 1.3 Å

10b. In a hypothetical Millikan-type oil-drop experiment we observed the following data representing the charges on a number of oil drops in 5 different experiments:

$$15, 27, 333, 159, 18$$

From this limited set of data points, we can conclude that the charge of an electron is

    a. between 15 and 333 units
    b. definitely 3 units
    c. possibly more than 3 units
    d. possibly less than 3 units

10c. Pick out the correct statement about percent ionic character for covalently bonded compound AB:

    a. It can be calculated via the electronegativities of A and of B.
    b. It can be calculated by measuring the dipole moment of AB and its bond length.
    c. Both of the above answers
    d. Neither of the above answers because AB is a covalent compound

10d. The Pauling scale for electronegativities:

    a. is based on an average of the IE (ionization energy) and the EA (electron affinity).
    b. is based on measurements of Coulomb energy, dissociation energy of AB into its atoms, and energy at infinite separation for $A + B \rightarrow A^+ + B^-$
    c. is based on measurements of the dissociation energies of AB, AA and BB into their respective atoms.
    d. is based on polling results by the Gallup organization.