October 24, 2001

Chemistry 101(Section 350)
Term Test #2

Time for Writing: 1 hour and 30 minutes Weight: 16 %

Total Marks: 49 Name: _____

I.D.#_____

1. [5] Aluminum carbide reacts with water to form methane gas according to the equation:

$$Al_4C_3(s) + 12H_2O(l) \longrightarrow 4Al(OH)_3(s) + 3CH_4(g)$$

The reaction between a 3.66 g sample of impure aluminum carbide and excess water generated 444 mL of methane gas measured over water at 22^oC. The external barometric pressure was 756 mmHg when the gas was collected. The experimenter noted that there was a column of water 2.32 cm high inside the glass collection vessel. Calculate the mass percent of Al_4C_3 in the sample.

2. [5] A certain compound containing only sulfur and nitrogen is 69.6 % sulfur by mass. A gaseous sample of the compound was found to have a density of 6.11g/L at 751 mmHg pressure and 90.^{o}C. Determine the molecular formula for this compound.

3. [6] Write down the electron configuration for each of the following ions and classify each as a *noble gas ion*, a *pseudo-noble gas ion* or an *inert- pair ion*.

a) In^{+}

b) Be^{2+}

c) Au^{+}

4. [6] On the basis of its electronic configuration and its position in the periodic table, predict the three most stable oxidation states for selenium (other than selenium(0)). Be sure to include the electron configuration for each oxidation state.

5. [4] a) Name the element whose 2+ ion has the electronic configuration $[Xe]4f^{14}5d^{4}$

   b) What two common first row transition-metal ions have a $3d^6$ valence shell configuration? How many unpaired electrons are there in a $3d^6$ ion?

6. [4] a) Provide an appropriate value for each of the missing quantum numbers:

   i) $n = 2,\ l = ?, m_l = -1, m_s = ½$

   i) $n = ?,\ l = 1, m_l = 1, m_s = ½$

   b) How many electrons in the second shell of an atom with Z >1 can have the quantum number $m_s = ½$?

7. [4] A certain gas cylinder A has a volume of 1.21 L and contains He at a pressure of 766 mmHg. Gas cylinder B, which is joined to Cylinder A via a closed stopcock, has a volume of 3.42 L and contains Ne gas at a pressure of 822 mm Hg. Calculate the partial pressures for helium and neon after the stopcock is opened. Assume the temperature remains constant at 16^{o}C.

8. [15] Fill in each blank with the appropriate answer.

i) Which element has the higher first ionization energy: Mg or Al? _____.

ii) The smallest cation is _____.

iii) The salt TcI_2 is _____ (diamagnetic/paramagnetic)

iv) The Sc^{3+} ion contains _____ unpaired electrons.

v) Which of the following would you expect to be attracted to an external magnetic field: Mg atom, Hg atom, Zn atom or Cl atom?_____.

vi) Which of the following species has the greatest number of unpaired electrons: S^+, S^- or S? _____.

vii) As we go down a particular vertical group in the periodic table, the ionization energy _____.

viii) The compound NCl_5 cannot be formed because it violates the _____ rule.

ix) Arrange the following ions in order of increasing ionic radius: O^{2-}, F^-, Na^+, Mg^{2+} : _____.

x) Provide the appropriate value for the missing quantum number :

n = 6, l = _____?, m_l = -3, m_s = -1/2.

Question # 8 continued

xi) Which of the following atoms has the largest effective nuclear charge: In, Sb or Sn?

_____.

xii) Which of the Group XV elements adopts only positive oxidation states in its compounds? _____.

xiii) How many orbitals are there in the n = 4 level of the hydrogen atom?

_____

xiv) How many d-electrons are there in a Pd atom? _____.

xiv) The sparseness of the emission spectrum for hydrogen suggests that energy of the electron in the hydrogen atom is:_____.

Bonus Question (2 marks):
Propose a plausible ground state electron configuration for element 113.
What is the maximum valency expected for this element?