2012 SPRING Semester Midterm Examination
For General Chemistry I

Date: March 28 (Wed), Time Limit: 7:00 ~ 9:00 p.m.

Write down your information neatly in the space provided below; print your Student ID in the upper right corner of every page.

Professor Name	Class	Student I.D. Number	Name

Problem	points	Problem	points	TOTAL pts
1	/10	**6**	/20	**/150**
2	/8	**7**	/15	
3	/12	**8**	/25	
4	/8	**9**	/20	
5	/12	**10**	/20	

** This paper consists of 10 sheets with 10 problems (page 9: claim form, page 10: periodic table). Please check all page numbers before taking the exam. Write down your work and answers in the Answer sheet.

Please write down the unit of your answer when applicable. You will get 30% deduction for a missing unit.

NOTICE: SCHEDULES on RETURN and CLAIM of the MARKED EXAM PAPER.

(채점답안지 분배 및 이의신청 일정)

1. Period, and Procedure

   1) Return and Claim Period: ***April 2 (Mon), Quiz Session; 7: 00 ~ 7:30***

   2) Procedure: During the quiz hour, you can take your mid-term paper scored. If you have any claims on it, you can submit a claim paper with your opinion. After writing your opinions on any paper you can get easily, attach it with a stapler to your mid-term paper scored (Please, write your name, professor, and class.). Submit them to your TA. The papers with the claims will be re-examined by TA.

***The claim is permitted only on the period. Keep that in mind*!**

(A solution file with answers for the examination will be uploaded on 3/31 at the web.)

2. Final Confirmation

   1) Period: April 9 (Mon)-10 (Tue)

   2) Procedure: During this period, you can check final score of the examination *on the website* again.

** For further information, please visit a *General Chemistry website* at www.gencheminkaist.pe.kr.

1. (a) Calculate the maximum wavelength of electromagnetic radiation needed to eject electrons from the surface of tungsten, which has a work function of 7.29×10^{-19} J.

(Answer)

(b) If the maximum speed of electrons emitted from the tungsten surface is 2.00×10^{6} m s^{-1}, calculate the wavelength of the incident radiation.

Planck's constant $h = 6.626 \times 10^{-34}$ J·s; speed of light $c = 2.998 \times 10^{8}$ m·s^{-1};

electron mass $m_e = 9.109 \times 10^{-31}$ kg

(Answer)

2. In many-electron atoms,

(a) Which of the quantum numbers govern the energy of an orbital?

(Answer)

(b) Which of the quantum numbers govern the shape and spatial orientation of an orbital?

Write the full name of each quantum number for (a) and (b).

(Answer)

3. Which of the following statements are true for many-electron atoms? If false, explain why.

(a) The effective nuclear charge Z_{eff} is independent of the number of electrons present in an atom.

(Answer)

(b) Electrons in an s-orbital are more effective than those in other orbitals at shielding other electrons from the nuclear charge because an electron in an s-orbital can penetrate to the nucleus of the atom.

(Answer)

(c) Electrons having $l = 2$ are better at shielding than electrons having $l = 1$.

(Answer)

(d) Z_{eff} for an electron in a p-orbital is lower than for an electron in as s-orbital in the same shell.

(Answer)

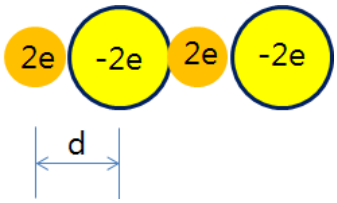
4. (a) Which has the larger second ionization energy, B or C, and why?

(Answer)

(b) Which is the largest and which is the smallest among K^+, Cl^-, and Ca^{2+}, and why?

(Answer)

5. (a) We learned that the Coulomb potential energy of the interaction of two individual ions is $\frac{z_1 z_2 e^2}{4\pi\varepsilon_0 r_{12}}$, where $z_1 e$ and $z_2 e$ are the charges of the two ions and r_{12} is the distance between two ions. Consider the following one-dimensional nanorod made of only four ions. The distance between two adjacent ions is d. The charge of each ion is indicated (2e or -2e). Calculate the total Coulomb potential energy of this system.



(Answer)

(b) In which of the nanorods $Mg^{2+}Se^{2-}Mg^{2+}Se^{2-}$ and $Ca^{2+}Se^{2-}Ca^{2+}Se^{2-}$ are the interactions between the ions stronger? Why?

(Answer)

6. (a) Write the Lewis structures of SO_2 and N_2O. Indicate the most stable structure for each molecule and explain the reason.

(Answer)

(b) Write the most probable Lewis structures of HNO and HON molecules. Which one would be energetically favored? Why?

(Answer)

7. Place the following molecules or ions in order of decreasing bond length, and explain the reason.

(a) the CO bond in CO, CO_2, CO_3^{2-}

(Answer)

(b) the SO bond in SO_2, SO_3, SO_3^{2-}

(Answer)

(c) the CN bond in HCN, CH_2NH, CH_3NH_2

(Answer)

8. (a) Use the VSEPR theory to sketch and name the molecular geometries of the molecules, SCl_2, SCl_4, and SCl_6, and state whether each is polar or nonpolar.

(Answer)

(b) Bromine can form compounds or ions with any number of fluorine atoms from one to five (BrF, BrF_2^-, BrF_3, BrF_4^-, BrF_5). Describe their geometries based on the VSEPR theory.

(Answer)

9. Use valence (VB) theory to predict the hybridization in formaldehyde and allene. Sketch the hybrid atomic orbitals depicting their overlap and σ and π-bonding.

(a) formaldehyde $H_2C=O$

(Answer)

(b) allene $H_2C=C=CH_2$

(Answer)

10. (a) Draw the molecular orbital energy-level diagram for N_2 and label the energy levels according to the type of orbitals from which they are made, whether they are σ or π-orbitals, and whether they are bonding or antibonding.

(Answer)

(b) The orbital structure of the heteronuclear diatomic ion NO^+ is similar to that of N_2. How will the fact that the electronegativity of N differs from that of O affect the molecular orbital energy-level diagram of NO^+ compared with that of N_2? Use this information to draw the energy-level diagram for NO^+.

(Answer)

(c) In the molecular orbitals, will the electrons have a higher probability of being at N or at O? Why?

(Answer)