淡江大學 106 學年度日間部寒假轉學生招生考試試題

21-1

系別：尖端材料科學學程二年級　　科目：普通化學

考試日期：1 月 6 日(星期六) 第 2 節　　本試題共 2 大題， 3 頁

**************請按題序作答並標示清楚答案之題號**************

第一部份：選擇題 （單選，每題 3 分，30 分）

1. A point in the wave function where the amplitude is zero defines
   (A) the node　(B) the ground state　(C) the excited state
   (D) the frequency of radiation　(E) the amplitude of the wave function

2. Which of the following has the shortest bond length?
   (A) O_2^{2-}　(B) O_2^{+}　(C) O_2^{-}　(D) O_2　(E) Two of these have the shortest bond length.

3. Choose the compound with the most ionic bond.
   (A) LiCl　(B) NaCl　(C) KF　(D) NaBr　(E) KI

4. Which of the following molecules or ions is paramagnetic in its ground state?
   (A) N_2　(B) O_2^{2+}　(C) C_2　(D) NO　(E) F_2

5. Which of the following solid substance can be described as very hard, having a high melting point, and nonconducting unless melted.
   (A) Graphite　(B) Diamond　(C) Fe　(D) Pt　(E) NaCl

6. Which of the following statement is ***true***?
   (A) Only four quantum numbers are needed to uniquely describe an electron.
   (B) The exact location of an electron can be determined if we know its energy.
   (C) The SI unit for frequency is hertz, which is defined as second per cycle.
   (D) Ni has three unpaired electrons in its 3*d* orbitals.
   (E) All matter exhibits either particulate or wave properties exclusively.

7. Assume 12,500 J of energy is added to 2.0 moles (36 grams) of H_2O as an ice sample at 0°C. The molar heat of fusion is 6.02 kJ/mol. The specific heat of liquid water is 4.18 J/g °C. The molar heat of vaporization is 40.6 kJ/mol. The resulting sample contains which of the following?
   (A) Only ice
   (B) Only water
   (C) Only water vapor
   (D) Ice and water
   (E) Water and water vapor

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8. A certain substance, *X*, has a triple-point temperature of 25°C at a pressure of 1.0 atm. Which one of the statements cannot possibly be true?
   (A) *X* can exist as a liquid above 25°C.
   (B) *X* can exist as a solid above 25 °C.
   (C) Liquid *X* can exist as a stable phase at 30°C, 0.5 atm.
   (D) Both liquid and solid *X* have the same vapor pressure at 25°C.
   (E) Different crystalline structures of X can be found below 25 °C

9. The energy differences between 4*s*, 4*p*, and 4*d* orbitals are due mainly to
   (A) the number of electrons they can hold
   (B) their principal quantum number
   (C) the Heisenberg uncertainty principle
   (D) the penetration effect
   (E) Hund's rule

10. Which of the following is the correct order of boiling points for H_2O, C_2H_6O, C_2H_6, Ar?
   (A) Ar < C_2H_6O < C_2H_6 < H_2O
   (B) H_2O < C_2H_6O < C_2H_6 < Ar
   (C) Ar < C_2H_6 < H_2O < C_2H_6O
   (D) C_2H_6 < Ar < C_2H_6O < H_2O
   (E) Ar < C_2H_6 < C_2H_6O < H_2O

第二部份：計算問答題（共 70 分）

1. Draw the Lewis structures for O_3, $BeCl_2$, SO_4^{2-}, and calculate the formal charges of the atoms in each molecule. ***(20%)***

2. The following two aqueous solutions are available for the preparation of a buffer solution.
   50 mL of 1.00 M NaOH, 100 mL of 0.50 M HA (Ka = 1.00 x 10^5)
   Describe how to prepare a buffer solution with maximum buffer capacity, and calculate the pH of the buffer solution. ***(15%)***

3. A salt, MY, crystallizes in a body-centered cubic structure with a Y^- anion at each cube corner and an M^+ cation at the cube center. The radius of Y^- is r_Y pm and that of M^+ is r_M pm. Assuming that the Y^- anions touch each other and the M^+ cation at the center, derive the expression of r_M in term of r_Y. ***(15%)***

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4. The reaction $H_2O_2 + 3I^- + 2H^+ \rightarrow I_3^- + 2H_2O$ may proceed via the following mechanism:

Step 1. $H_2O_2 + H^+ \rightleftharpoons H_3O_2^+$ (rapid equilibrium, equilibrium constant = K)
Step 2. $H_3O_2^+ + I^- \rightarrow H_2O + HOI$ (slow, rate constant k_2)
Step 3. $HOI + I^- \rightarrow OH^- + I_2$ (fast, rate constant k_3)
Step 4. $OH^- + H^+ \rightarrow H_2O$ (fast, rate constant k_4)
Step 5. $I_2 + I^- \rightarrow I_3^-$ (fast, rate constant k_5)

Derive the differential rate law for the reaction. Use [i], concentration of the reactant i, and the provided constant to express your answer. ***(10%)***

5. Given the following two reactions at 298 K and 1 atm,

$N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\quad \Delta H_1$
$NO(g) + \frac{1}{2} O_2(g) \rightarrow NO_2(g)$ $\quad \Delta H_2$

Derive the standard enthalpy of formation, $\Delta H_f°$, for $NO_2(g)$ ***(10%)***