國立高雄大學 112 學年度研究所碩士班招生考試試題

科目：普通化學　　　　　系所：應用化學系　　　　是否使用計算機：是

考試時間：100 分鐘　　　本科原始成績：100 分

一、選擇題 (每題三分，共六十分)

1. (　) What is the weakest intermolecular force?
   - (A) ionic bonding　　　(B) polar covalent bonds　　　(C) London dispersion forces
   - (D) hydrogen bonding　(E) dipole-dipole interactions

2. (　) Which of the following electromagnetic wave has the shortest wavelength?
   - (A) infrared　　　(B) visible　　　(C) ultraviolet
   - (D) microwave　　(E) X-ray

3. (　) Which of the following statement is _true_ for a neutral solution?
   - (A) $[H^+] = [OH^-]$
   - (B) $[H_2O] = 1 \times 10^{-14}$
   - (C) $K_w = 1 \times 10^{-14}$ at 50 °C
   - (D) $[OH^-] = 0$ M
   - (E) pH = 7 at 100 °C

4. (　) Which of the following statements regarding oxidation and reduction is _correct_?
   - (A) accompany all chemical changes
   - (B) occur independently of each other
   - (C) It cannot predict the direction of the reaction using Le Châtelier's principle.
   - (D) describe the loss and gain of electron(s), respectively.

5. (　) Arrange the following compounds according to decreasing solubility in water.
   - a. CH_3OH
   - b. CH_3CH_2OH
   - c. $CH_3CH_2OCH_2CH_3$
   - d. $CH_3CH_2CH_2CH_3$
   - (A) b > a > c > d　　　(B) c > a > b > d　　　(C) a > b > c > d
   - (D) d > c > a > b　　　(E) none of these

6. (　) Arrange the elements Ba, Be, Ca, and Mg in order of decreasing atomic radius.
   - (A) Be > Mg > Ca > Ba　　(B) Ba > Ca > Mg > Be　　(C) Be > Ca > Mg > Ba
   - (D) Ba > Mg > Ca > Be　　(E) none of these

7. (　　) When the following equation is balanced, what are the coefficients?

$$w C_5H_{12} + x O_2 \rightarrow y CO_2 + z H_2O$$
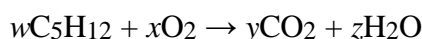
    (A)　　$w = 1,\ x = 8,\ y = 5,\ z = 6$

    (B)　　$w = 2,\ x = 10,\ y = 10,\ z = 12$

    (C)　　$w = 1,\ x = 5,\ y = 5,\ z = 0$

    (D)　　$w = 1,\ x = 5,\ y = 5,\ z = 6$

    (E)　　none of these

8. (　　) Which of the following molecule has the *largest* bond angle?

    (A)　CO　　　(B)　O_3　　　(C)　H_2O　　　(D)　PCl_5　　　(E)　NH_3

9. (　　) What is the electron configuration for the $_{28}Ni$ atom?

    (A)　$[Kr]\ 4s^2 3d^8$　　　(B)　$[Ar]\ 3d^{10}$　　　(C)　$[Kr]\ 3d^{10}$

    (D)　$[Ar]\ 4s^2 3d^8$　　　(E)　none of these

10. (　　) An *sp* hybridized atom forms _____ pi bond(s).

    (A)　1　　　(B)　2　　　(C)　3　　　(D)　4　　　(E)　0

11. (　　) Which of the following sets of quantum numbers is *not* allowed? (Combinations are listed as follows: principal quantum number (n), momentum quantum number (l), magnetic quantum number(m_l), electron spin quantum number (m_s).)

    (A)　　$n = 4,\ l = 0,\ m_l = 0,\ m_s = + 1/2$

    (B)　　$n = 6,\ l = 4,\ m_l = 4,\ m_s = - 1/2$

    (C)　　$n = 5,\ l = 3,\ m_l = 1,\ m_s = + 1/2$

    (D)　　$n = 2,\ l = 2,\ m_l = 0,\ m_s = - 1/2$

    (E)　　$n = 3,\ l = 1,\ m_l = 0,\ m_s = + 1/2$

12. (　　) Given the following reaction, $A_2(g) + B_2(s) \rightleftharpoons 2AB(g)$　　　　$\Delta H = -90.0$ kJ/mol
    Which of the following statements about the equilibrium is *false*?

    (A)　　This is a heterogeneous reaction.

    (B)　　Adding more A to the system increases the equilibrium constant.

    (C)　　Removing AB forces the system shift to the right.

    (D)　　If the system is heated, the left side is favored.
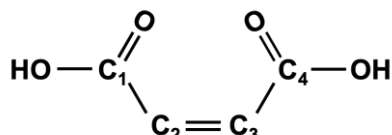
(E)　　If the pressure on the system is increased by changing the volume, the left side is favored.

13. (　　) Consider the following structure of the maleic acid.

Which carbon in this molecule has tetrahedral bonding?

(A) 4　　　　(B) 3　　　　(C) 2　　　　(D) 1　　　　(E) none of these

14. (　　) What is the hybridization of the S atom in SF_6?
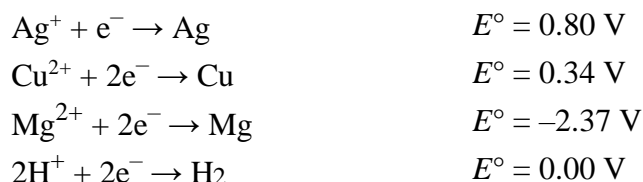
(A) sp^3　　　　(B) sp　　　　(C) sp^2　　　　(D) d^2sp^3　　　　(E)　　dsp^3

15. (　　) Which of the following is *not* a conjugated acidic-base pair?

(A)　HSO_3^- and SO_4^{2-}　　　　(B) HPO_4^{2-} and PO_4^{3-}　　　　(C) CH_3COOH and CH_3COO^-

(D)　NH_4^+ and NH_3　　　　(E) none of these

16. (　　) Which of the following is the equilibrium constant expression for the dissociation of the weak acid HNO_2?

(A)　$K_a = \dfrac{[HNO_2]}{[H^+][NO_2^-]}$　　　　(B)　$K_a = [H^+][NO_2^-]$　　　　(C)　$K_a = \dfrac{[H^+][NO_2^-]}{[HNO_2]}$

(D)　$K_a = [HNO_2]$　　　　(E) none of these

17. (　　) Which of the following is the best oxidizing agent?

$Ag^+ + e^- \rightarrow Ag$　　　　　　$E° = 0.80$ V

$Cu^{2+} + 2e^- \rightarrow Cu$　　　　　$E° = 0.34$ V

$Mg^{2+} + 2e^- \rightarrow Mg$　　　　$E° = -2.37$ V

$2H^+ + 2e^- \rightarrow H_2$　　　　　$E° = 0.00$ V

(A) H_2　　　　(B) Ag^+　　　　(C) Cu^{2+}　　　　(D) Mg^{2+}　　　　(E) H^+

18. (　　) One mole of an ideal gas is expanded from a volume of 2.00 L to a volume of 10.00 L against a constant external pressure of 0.80 atm.　Calculate the work.

(1 L·atm = 101.32 Joules)

(A)　6.20×10^2 J　　(B)　-6.48×10^2 J　　(C)　6.48 J

(D) -0.066 J　　　　　(E)　none of these

19. (　) Based on the phase diagram of water below, At 0 °C and 1 atm, what will be the state of water?
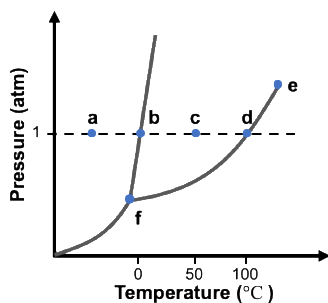
(A)　liquid/solid at equilibrium　　　(B) solid　　(C)　liquid

(D)　gas/solid at equilibrium　　　　(E) gas

20. (　) A general reaction written as A + B → C + D is studied and yields the following results.

initial concentration of A	initial concentration of B	Initial rate
0.100 M	0.0050 M	1.35×10^{-7} mol/L • s
0.100 M	0.010 M	2.70×10^{-7} mol/L • s
0.200 M	0.010 M	5.40×10^{-7} mol/L • s

Which of the following is the correct rate law?

(A)　　Rate $= k[A]^2$

(B)　　Rate $= k[A]^2[B]^2$

(C)　　Rate $= k[A][B]^2$

(D)　　Rate $= k[A]^2[B]$

(E)　　Rate $= k[A][B]$

二、問答與計算題 (共四十分)

21. Name the following compounds. (**10 points**)

　(a) K_2SO_4　　(b) $Fe(NO_3)_2$　　(c) $NaHCO_3$　　(d) $Mg(OH)_2$　　(e) CuI_2

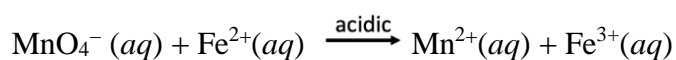科目：普通化學　　　　系所：應用化學系　　　　是否使用計算機：是
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22. Draw Lewis structures for the each molecule or ion. (**6 points**)

(a) NO_3^-　　　(b) XeO_3　　　(c) $BeCl_2$

23. The ion $^{206}_{82}Pb^{2+}$ has (a)_____ protons, (b)_____ neutrons, and (c)_____ electrons. (**6 points**)

24. (a) Balance the following equation using oxidation states. (**4 points**)

$$MnO_4^-\ (aq) + Fe^{2+}(aq) \xrightarrow{\text{acidic}} Mn^{2+}(aq) + Fe^{3+}(aq)$$

(b) A 25.00 mL sample solution containing Fe^{2+} ions is titrated with a 0.0200 M KMO_4. It required 16.51 mL of $KMnO_4$ solution to oxidize all the Fe^{2+} to Fe^{3+} ions. Calculate the concentration of Fe^{2+} ions in the sample solution. (**4 points**)

25. Consider the following reaction:

$2NH_3(g) + 3CuO(s) \rightarrow N_2(g) + 3Cu(s) + 3H_2O(g)$　　　　　(**5 points**)
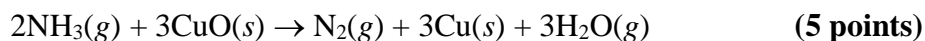
(a) Indicate the limiting reactant when 20.1 g of NH_3 is reacted with 88.5 g of CuO.

(b) Calculate the number of moles of N_2 gas formed in (a).

(atomic mass for Cu = 63.5, H= 1.0, O=16.0, N=14.0)

26. Describe in detail how to prepare 50 mL of 0.150 M NaCl aqueous solution from the solid. (molar mass for Na = 22.99 g/mol, Cl = 35.45 g/mol) (**5 points**)