臺灣綜合大學系統 105 學年度學士班轉學生聯合招生考試試題

科目名稱	普通化學 B	類組代碼	E00
		科目碼	E0018
※本項考試依簡章規定各考科均「不可以」使用計算機		本試題共計 **3** 頁	

說明：答案一律寫在答案卷上；請依序作答，並標明題號。

（$h=6.626 \times 10^{-34}$ J s, R= 8.314 J/mol K, $K_a(NH_4^+)$: 5.6×10^{-10}, $K_a(HNO_2)$: 4.0×10^{-4}, $K_{a1}(H_2CO_3)$: 4.3×10^{-7}, $K_{a2}(H_2CO_3)$: 4.8×10^{-11}）

一、選擇題：（單選 21 題，每題 3 分，不倒扣，共 63 分）

1. The wave function of 2s orbital for hydrogen atom is $A[2-(r/a_o)] \exp(-r/(2a_o))$.
Calculate the ratio of the probability of finding the electron at $r= 4a_o$ relative to that at $r=a_o$?
(A)$4e^{-3}$ (B)$4e^{-1}$ (C)$2e^{-3}$ (D)$2e^{-3/2}$ (E)$4e^{-3/2}$

2. The percentage of the ionic character of H-Cl bond is 18.2 %. The bond length is 1.27×10^{-8} cm. What's the dipole moment (in D) of HCl(g)? (Note: $e=1.6 \times 10^{-19}$ coul, D= 3.336×10^{-30} Coul m)
(A)1.56 (B)2.24 (C)0.95 (D)1.87 (E)1.11

3. For how many of the following species (B_2^-, C_2, N_2^-, O_2^-, and F_2) does the bond order decrease if one electron is removed?
(A)0 (B)1 (C)2 (D)3 (E)4

4. Rank the following bonds in order from less polar to most polar: (1)P-S, (2)Ca-S, (3)K-Cl, (4)Si-Cl, (5)K-F.
(A)1, 4, 2, 3, 5 (B)1, 2, 4, 5, 3 (C)4, 1, 2, 3, 5 (D)4, 1, 3, 2, 5 (E)1, 4, 2, 5, 3

5. How many of the following molecules or ions ($IO_2F_2^-$, TeF_4, ICl_3, XeF_4, ClO_4^-, SOF_4) have see-saw (翹翹板) structures?
(A)2 (B)3 (C)4 (D)5 (E)6

6. How many molecules or ions listed in Problem 5 have a hybridization of dsp^3 on the central atom?
(A)3 (B)4 (C)5 (D)6 (E)7

7. How many of the followings (CN^-, NO^-, O_2, OF^+, OF^-) are paramagnetic?
(A)1 (B)2 (C)3 (D)4 (E)5

8. Rank the following 0.10 M solutions in order from most acidic to most basic:
(1)$CaBr_2$, (2)KNO_2, (3)NH_4ClO_4, (4)NH_4NO_2, (5)HNO_2
(A)5, 3, 1, 2, 4 (B)3, 5, 2, 4, 1 (C)5, 3, 4, 2, 1 (D)5, 3, 4, 1, 2 (E)5, 4, 1, 3, 2

9. In a common car battery, six identical cells each carry out the following reaction:
$$Pb + PbO_2 + 2HSO_4^- + 2H^+ \rightarrow 2PbSO_4 + 2H_2O$$
For such a cell, $E°$ is 2.04 V. Calculate $\Delta G°$ (in kJ) at 25°C.
(A) –787 (B) –1182 (C) –394 (D) –197 (E) –2364

10. The reaction $2A + B \rightarrow C$ has the following proposed mechanism:

Step 1: $A + B \rightleftharpoons D$ (rate constant: k_1 and k_{-1}, fast equilibrium)

Step 2: $D + B \rightarrow E$ (rate constant: k_2)

Step 3: $E + A \rightarrow C + B$ (rate constant: k_3)

If step 2 is the rate-determining step, what should be the rate of formation of C?

(A)$k[A]$ (B)$k[A]^2[B]$ (C)$k[A][B]^2$ (D)$k[A][B]$ (E)$k[A]^2[B]^2$

背面有題，請繼續作答。

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11. Consider the titration of 50.0 ml of 0.10 M acetic acid (Ka= 1.8×10^{-5}) with 0.10 M NaOH. Calculate [H^+] (in M) if 25.0 ml of NaOH is added?
    (A)1.2×10^{-6}　　　(B)3.8×10^{-6}　　　(C)7.5×10^{-6}　　　(D)1.8×10^{-5}　　　(E)5.4×10^{-5}

12. Same as Problem 11, but calculate [H^+] (in M) if 50.0 ml (total) of NaOH is added?
    (A)1.9×10^{-9}　　　(B)3.2×10^{-9}　　　(C)7.5×10^{-9}　　　(D)1.9×10^{-8}　　　(E)3.6×10^{-8}

13. The complex FeL_6^{2+}, where L is a neutral ligand, is known to be diamagnetic. The number of d electrons in this complex ion is:
    (A)4　　　(B)5　　　(C)6　　　(D)7　　　(E)8

14. For the process　$Co(NH_3)_5Cl^{2+} + Cl^- \rightarrow Co(NH_3)_4Cl_2^+ + NH_3$, what would be the ratio of cis to $trans$ isomers in the product?
    (A)1:1　　(B)1:2　　(C)1:4　　(D)4:1　　(E)2:1

15. Consider 2.0 mole of a monatomic ideal gas that is taken from state A (P_A= 2.0 atm, V_A= 10.0 L) to state B (P_B= 2.0 atm, V_B= 30.0 L), and then to state C (P_C= 1.0 atm, V_C= 30.0 L). Calculate ΔE_{AB} (in atm L).
    (A)30　　　(B)36　　　(C)45　　　(D)52　　　(E)60

16. Same as Problem 15, but calculate ΔH_{BC} (in atm L).
    (A)-38　　　(B)-60　　　(C)-75　　　(D)-82　　　(E)-90

17. Same as Problem 15, but calculate ΔS_{AB}.
    (A)(5/2)Rln2　　　(B)5Rln3　　　(C)3Rln3　　　(D)(5/2)Rln3　　　(E)(3/2)Rln3

18. Consider a face-centered cubic unit cell. What's the fraction of the space actually occupied by the packed sphere?
    (A)0.68　　　(B)0.72　　　(C)0.74　　　(D)0.76　　　(E)0.78

19. Which of the following compounds doesn't react with the acidic KMnO₄ solution?
    (A)propanol　　(B)isopropanol　　(C)2-methyl-1-propanol　　(D)2-methyl-2-propanol
    (E)glycerol

20. Which of the following is optically active (that is, chiral)?
    (A)dimethylamine　　(B)difluoromethane　　(C)2-chloropropane　　(D)2-chlorobutane
    (E)1-bromohexane

21. When heat is added to proteins, the hydrogen bonding in the secondary structure breaks apart. What are the algebraic signs of ΔH and ΔS for the denaturation process?
    (A)Both ΔH and ΔS are positive.　　　(B)Both ΔH and ΔS are negative.
    (C)ΔH is positive and ΔS is negative.　　　(D)ΔH is negative and ΔS is positive.
    (E)ΔH is positive and ΔS is 0.

二、非選擇題：（共 37 分，計算題務必列出計算過程，只寫答案不計分）

1. Consider the model for a particle of mass m in a one-dimensional box of size L. The potential is 10 inside the box, and infinite outside the box. (14 %)
    (a)Solve the Schrodinger equation by using A sin(kx) as a trial solution to determine k and total energy E in terms of quantum number n.
    (b)What's the probability of finding the particle between L/3 to L/2 if n = 3?

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2. Consider a second order reaction   A + B → P
   , where the rate equation is $d[P]/dt = k [A] [B]$ and $[B]_0 = 2 [A]_0 = 2 a$.   (9 %)
   (a)Derive the expression of $\ln ([B]/ [A])$ as a function of a, k, and t.
   (b)Calculate the time required for half of A is reacted.

3. Consider a Van der Waals gas.   (14 %)
   (a)If the molecular attraction can be neglected, derive the expression of PV as a function of
      P and T, and plot PV vs. P.
   (b)If the excluded volume effect can be neglected, derive the expression of PV as a function of
      P and T , and plot PV vs. P.   (Hint: use $PV= nRT$ as approximation if needed.)

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