臺灣綜合大學系統106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A	類組代碼	
		科目碼	E0017

※本項考試依簡章規定各考科均「不可以」使用計算機　　本科試題共計 3 頁

說明：答案一律寫在答案卷上；請依序作答，並標明題號。

(R: 8.314 J/mol K, $K_a(NH_4^+)$: 5.6×10^{-10}, $K_a(HNO_2)$: 4.0×10^{-4}, $K_a(HF)$: 7.2×10^{-4}, $K_a(HCN)$: 6.2×10^{-10}, $K_a(phenol)$: 1.6×10^{-10})

一、選擇題：（單選25題，每題3分，不倒扣，共75分）

1. Order the following 0.10 M solutions ((1)NH_4CN, (2)KNO_2, (3)NH_4ClO_4, (4)NH_4NO_2, (5)HF) in order from most acidic to most basic.
(A)5, 3, 1, 2, 4 (B)5, 4, 3, 2, 1 (C)5, 3, 4, 2, 1 (D)5, 3, 4, 1, 2 (E)5, 4, 3, 1, 2
2. Calculate the $[H^+]$ (in 10^{-7} M) in a 4.0×10^{-5} M phenol.
(A)1.3 (B)1.8 (C)0.8 (D)1.2 (E)1.4
3. Which of the following species ((1)N_2, (2)O, (3)O_2, (4)N_2^{2-}, (5)O_2^+) has the smallest ionization energy?
(A)1 (B)2 (C)3 (D)4 (E)5
4. How many of the following molecules or ions (TeF_4, ClF_3, CO_3^{2-}, Br_3^-, ICl_3, SOF_4) have T-shaped structures?
(A)1 (B)2 (C)3 (D)4 (E)5
5. How many molecules or ions listed in Problem 4 have a hybridization of dsp^3 on the central atom?
(A)1 (B)2 (C)3 (D)4 (E)5
6. A carbon-carbon double bond shows a vibration at about 1650 cm^{-1}. If the absorbance is 0.7, what is the percent transmittance? (Note: log 5 = 0.7)
(A)20 (B)28 (C)32 (D)36 (E)40
7. Order the following ((1)H_2O, (2)F^-, (3)Cl^-, (4)Br^-, (5)CN^-) in order of increasing base strength.
(A)1, 3, 4, 2, 5 (B)3, 4, 1, 2, 5 (C)5, 2, 1, 4, 3 (D)4, 3, 1, 2, 5 (E)5, 2, 1, 3, 4
8. In the gas phase, the production of phosgene from chlorine and carbon monoxide is assumed to proceed by the following mechanism:

$Cl_2 \rightleftharpoons 2\,Cl$ (forward and back rate constant: k_1 and k_{-1}, fast equilibrium)

$Cl + CO \rightleftharpoons COCl$ (forward and back rate constant: k_2 and k_{-2}, fast equilibrium)

$COCl + Cl_2 \rightarrow COCl_2 + Cl$ (rate constant: k_3, slow)

$2\,Cl \rightarrow Cl_2$ (rate constant: k_4, fast)

If the rate law is written as $-d[CO]/dt = K[CO]^m[Cl_2]^n$, determine the value of K.

(A)$k_3\,k_2\,k_1^{1/2}/\,k_{-2}\,k_{-1}^{1/2}$ (B)$k_3\,k_2\,k_1/\,k_{-2}\,k_{-1}$ (C)$k_3\,k_1\,k_2^{1/2}/\,k_{-1}\,k_{-2}^{1/2}$ (D)$k_3\,k_2\,k_{-1}^{1/2}/\,k_{-2}\,k_1^{1/2}$ (E)$k_3\,k_{-2}\,k_1^{1/2}/\,k_2\,k_{-1}^{1/2}$
9. What's the value of n in Problem 8?
(A)1/2 (B)1 (C)3/2 (D)2 (E)5/2
10. Consider the ionic solid MX, where the X^- ions form a closet packed array. If the radius ratio M^+/X^- is 0.45, what kind of hole would the M^+ ions be placed?
(A)tetrahedral (B)octahedral (C)cubic (D)face centered (E)none of above
11. Consider the model for a particle of mass m in a one-dimensional box with length L. The potential is 0 inside the box, and infinite outside the box. What is the probability of finding the particle between L/2 to 5L/8 if the quantum number is equal to 4?
(A)1/8 (B)1/6 (C)1/4 (D)5/12 (E)2/5
12. Which of the following locations has the highest probability to find the particle in Problem 11?
(A)L/6 (B)3L/8 (C)L/3 (D)2L/3 (E)4L/5

 背面有題，請繼續作答。

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13. How many of the following species ($H_2C=CH_2$, ICl_4^-, H_2CO, NH_3, NO_3^-, H_2O_2, $CH_2=C=CH_2$) have all of their atoms on the same plane?
(A)2 (B)3 (C)4 (D)5 (E)6

14. Consider molecules H_2, HD, and D_2. (D is the isotope of H, with atomic mass 2.) Assuming that the bonds in these molecules have the same vibrational force constant, calculate the ratio of the characteristic vibration frequency H_2: HD: D_2.
(A)4: 3: 2 (B)3: 4: 6 (C)$3^{1/2}$: 2: $6^{1/2}$ (D)$2^{1/2}$: $3^{1/2}$: 2 (E)2: $3^{1/2}$: $2^{1/2}$

15. How many of the following complexes ($[Ti(H_2O)_6]^{2+}$, $[CoCl_6]^{3-}$, $[Cu(en)_3]^{2+}$, $[Mn(NH_3)_6]^{2+}$, $[Fe(CN)_6]^{-4}$) are paramagnetic?
(A)1 (B)2 (C)3 (D)4 (E)5

16. Which is correct for the systematic name of $[Fe(en)_2Cl_2]_2SO_4$?
(A)dichlorinebis(ethylenediamine)ferrate(III) sulfate
(B)sulfate dichlorinebis(ethylenediamine)iron(III)
(C)dichlorobis(ethylenediamine)ferrate(III) sulfate
(D)dichlorobis(ethylenediamine)iron(III) sulfate
(E)bis(dichlorobis(ethylenediamine)iron(III)) sulfate

17. Which of the following will absorb the visible light with the highest energy?
(A)$[Co(H_2O)_6]^{3+}$ (B)$[CoI_6]^{3-}$ (C)$[Co(OH)_6]^{3-}$ (D)$[Co(en)_3]^{3+}$ (E)$[Co(NH_3)_6]^{3+}$

18. When 4.0 mole of $SO_2(g)$ react completely with 2.0 mole of $O_2(g)$ at 25 °C and 1.0 atm, 396 kJ of energy is released as heat. Calculate ΔE (in kJ) for this process.
(A)-196 (B)-394 (C)-396 (D)-391 (E)-389

19. If $SO_2(g)$, $O_2(g)$, and $SO_3(g)$ have the same pressure, the process
$$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$$
(A) is spontaneous at low temperature and high pressure. (B)is spontaneous at low temperature and low pressure. (C)is spontaneous at high temperature and high pressure. (D)is spontaneous at high temperature and low pressure. (E)is spontaneous at any temperature.

20. 5.0 mole monatomic ideal gas at 298 K and 10.0 atm is expanded isothermally and reversibly to 1.0 atm. Calculate the ΔG_{sys} (in kJ).
(A)0 (B)0.096 (C)0.16 (D)-5.70 (E)-28.5

21. What's the q (in kJ) in the surroundings in Problem 20?
(A)–0.16 (B)5.7 (C)-28.5 (D)-5.7 (E)0

22. A sample of 2.0 mole water, initially at 100 °C, is heated to 140 °C at a constant pressure of 1.0 atm. Calculate ΔS (in J/K) for this process. The heat of vaporization is 40.7 kJ/mol, and the molar heat capacity gaseous water is 36.4 J/K,mol. (Note: ln(413/373)= 0.1)
(A)116 (B)215 (C)109 (D)226 (E)68

23. Consider the molecule *trans*-2-butene. Which statement is true?
(A)There is free rotation around every bond in the molecule. (B)*Cis*-2-butene is its structural isomer. (C)Carbon #2 exhibits sp^2 hybridization. (D)The molecule has two π bonds.
(E)none of above.

24. Which of the following yields a primary alcohol upon reduction?
(A)a ketone (B)an aldehyde (C)an alkene (D)an amine (E)an ether

25. When the following organic compound is oxidized, what is the major organic product?
$(CH_3CH_2)_2CHOH + KMnO_4$
(A)3-pentanal (B)3-pentanoic acid (C)diethylether (D)3-pentanol (E)3-pentanone

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二、非選擇題：（共25分，計算題務必列出計算過程，只寫答案不計分）

1. Calculate $[H^+]$ and [HCN] of a 0.20 M NH_4CN solution. (Note: $0.9^{1/2} = 0.95$)

(8 %)

2. A typical mechanism for the conversion of a biochemical substrate (S) to product (P) catalyzed by an enzyme (E) involves the following steps:

$$E + S \rightleftharpoons ES \quad \text{(forward and back rate constant: } k_1 \text{ and } k_{-1})$$

$$ES \rightarrow P \quad \text{(rate constant: } k_2)$$

The rate-determining step is the decomposition of the enzyme–substrate complex (ES) to product.
(a)Derive the expression of d[P]/dt as a function of k_1, k_{-1}, k_2, [S], and $[E]_o$, where $[E]_o = [E] + [ES]$.
(b)Calculate d[P]/dt under the condition $k_1[S] >> (k_{-1} + k_2)$.

(12 %)

3. Consider the $CHCl_3$ molecule, where all the bond angles are 109.5°. If the dipole moment for C-H and C-Cl bond is x and y, respectively, calculate the net dipole moment for $CHCl_3$.

(5 %)