

臺灣綜合大學系統

106 學年度

轉學生聯合招生考試

# 試 題

類組：A04/A05/A09/B05/

B30/C08

科目名稱：普通化學 A

科目代碼：E0017

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

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※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,  $K_a(\text{NH}_4^+)$ :  $5.6 \times 10^{-10}$ ,  $K_a(\text{HNO}_2)$ :  $4.0 \times 10^{-4}$ ,  $K_a(\text{HF})$ :  $7.2 \times 10^{-4}$ ,  
 $K_a(\text{HCN})$ :  $6.2 \times 10^{-10}$ ,  $K_a(\text{phenol})$ :  $1.6 \times 10^{-10}$ )

一、選擇題：(單選 25 題，每題 3 分，不倒扣，共 75 分)

- Order the following 0.10 M solutions ((1) $\text{NH}_4\text{CN}$ , (2) $\text{KNO}_2$ , (3) $\text{NH}_4\text{ClO}_4$ , (4) $\text{NH}_4\text{NO}_2$ , (5) $\text{HF}$ ) 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
- Calculate the  $[\text{H}^+]$  (in  $10^{-7} \text{ M}$ ) in a  $4.0 \times 10^{-5} \text{ M}$  phenol.  
 (A)1.3 (B)1.8 (C)0.8 (D)1.2 (E)1.4
- Which of the following species ((1) $\text{N}_2$ , (2) $\text{O}$ , (3) $\text{O}_2$ , (4) $\text{N}_2^{2-}$ , (5) $\text{O}_2^+$ ) has the smallest ionization energy?  
 (A)1 (B)2 (C)3 (D)4 (E)5
- How many of the following molecules or ions ( $\text{TeF}_4$ ,  $\text{ClF}_3$ ,  $\text{CO}_3^{2-}$ ,  $\text{Br}_3^-$ ,  $\text{ICl}_3$ ,  $\text{SOF}_4$ ) have T-shaped structures?  
 (A)1 (B)2 (C)3 (D)4 (E)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
- A carbon-carbon double bond shows a vibration at about  $1650 \text{ cm}^{-1}$ . 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
- Order the following ((1) $\text{H}_2\text{O}$ , (2) $\text{F}^-$ , (3) $\text{Cl}^-$ , (4) $\text{Br}^-$ , (5) $\text{CN}^-$ ) 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
- In the gas phase, the production of phosgene from chlorine and carbon monoxide is assumed to proceed by the following mechanism:  

$$\text{Cl}_2 \rightleftharpoons 2 \text{Cl} \quad (\text{forward and back rate constant: } k_1 \text{ and } k_{-1}, \text{ fast equilibrium})$$

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

$$\text{COCl} + \text{Cl}_2 \rightarrow \text{COCl}_2 + \text{Cl} \quad (\text{rate constant: } k_3, \text{ slow})$$

$$2 \text{Cl} \rightarrow \text{Cl}_2 \quad (\text{rate constant: } k_4, \text{ fast})$$
 If the rate law is written as  $-\text{d}[\text{CO}]/\text{dt} = K[\text{CO}]^m[\text{Cl}_2]^n$ , 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) $k_3 k_{-2} k_1^{1/2} / k_2 k_{-1}^{1/2}$
- What's the value of n in Problem 8?  
 (A)1/2 (B)1 (C)3/2 (D)2 (E)5/2
- Consider the ionic solid MX, where the  $\text{X}^-$  ions form a closet packed array. If the radius ratio  $M^+/\text{X}^-$  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
- 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
- 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

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<p>13. How many of the following species (<math>\text{H}_2\text{C}=\text{CH}_2</math>, <math>\text{ICl}_4^-</math>, <math>\text{H}_2\text{CO}</math>, <math>\text{NH}_3</math>, <math>\text{NO}_3^-</math>, <math>\text{H}_2\text{O}_2</math>, <math>\text{CH}_2=\text{C}=\text{CH}_2</math>) have all of their atoms on the same plane?                      (A)2 (B)3 (C)4 (D)5 (E)6</p> <p>14. Consider molecules <math>\text{H}_2</math>, HD, and <math>\text{D}_2</math>. (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 <math>\text{H}_2</math>: HD: <math>\text{D}_2</math>.                      (A)4: 3: 2 (B)3: 4: 6 (C)<math>3^{1/2}</math>: 2: <math>6^{1/2}</math> (D)<math>2^{1/2}</math>: <math>3^{1/2}</math>: 2 (E)2: <math>3^{1/2}</math>: <math>2^{1/2}</math></p> <p>15. How many of the following complexes (<math>[\text{Ti}(\text{H}_2\text{O})_6]^{2+}</math>, <math>[\text{CoCl}_6]^{3-}</math>, <math>[\text{Cu}(\text{en})_3]^{2+}</math>, <math>[\text{Mn}(\text{NH}_3)_6]^{2+}</math>, <math>[\text{Fe}(\text{CN})_6]^{4-}</math>) are paramagnetic?                      (A)1 (B)2 (C)3 (D)4 (E)5</p> <p>16. Which is correct for the systematic name of <math>[\text{Fe}(\text{en})_2\text{Cl}_2]_2\text{SO}_4</math>?                      (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</p> <p>17. Which of the following will absorb the visible light with the highest energy?                      (A)<math>[\text{Co}(\text{H}_2\text{O})_6]^{3+}</math> (B)<math>[\text{CoI}_6]^{3-}</math> (C)<math>[\text{Co}(\text{OH})_6]^{3-}</math> (D)<math>[\text{Co}(\text{en})_3]^{3+}</math> (E)<math>[\text{Co}(\text{NH}_3)_6]^{3+}</math></p> <p>18. When 4.0 mole of <math>\text{SO}_2(\text{g})</math> react completely with 2.0 mole of <math>\text{O}_2(\text{g})</math> at 25 °C and 1.0 atm, 396 kJ of energy is released as heat. Calculate <math>\Delta E</math> (in kJ) for this process.                      (A)-196 (B)-394 (C)-396 (D)-391 (E)-389</p> <p>19. If <math>\text{SO}_2(\text{g})</math>, <math>\text{O}_2(\text{g})</math>, and <math>\text{SO}_3(\text{g})</math> have the same pressure, the process  <math display="block">2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{SO}_3(\text{g})</math>                     (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.</p> <p>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 <math>\Delta G_{\text{sys}}</math> (in kJ).                      (A)0 (B)0.096 (C)0.16 (D)-5.70 (E)-28.5</p> <p>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</p> <p>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 <math>\Delta S</math> (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: <math>\ln(413/373) = 0.1</math>)                      (A)116 (B)215 (C)109 (D)226 (E)68</p> <p>23. Consider the molecule <i>trans</i>-2-butene. Which statement is true?                      (A)There is free rotation around every bond in the molecule. (B)<i>Cis</i>-2-butene is its structural isomer. (C)Carbon #2 exhibits <math>\text{sp}^2</math> hybridization. (D)The molecule has two <math>\pi</math> bonds. (E)none of above.</p> <p>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</p> <p>25. When the following organic compound is oxidized, what is the major organic product?  <math>(\text{CH}_3\text{CH}_2)_2\text{CHOH} + \text{KMnO}_4</math>                      (A)3-pentanal (B)3-pentanoic acid (C)diethylether (D)3-pentanol (E)3-pentanone</p>			

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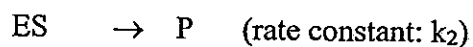
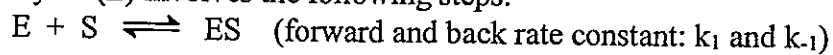
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二、非選擇題：（共 25 分，計算題務必列出計算過程，只寫答案不計分）

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:



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  $[E]_0$ , where  $[E]_0 = [E] + [ES]$ .

(b) Calculate  $d[P]/dt$  under the condition  $k_1[S] \gg (k_{-1} + k_2)$ .

(12 %)

3. Consider the  $CHCl_3$  molecule, where all the bond angles are  $109.5^\circ$ . 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 %)