

# 國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：普通化學【醫科所碩士班選考】

題號：428004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（混合題）

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一、問答與計算題（請將答案卷中標示題號並依序作答）

1. Define "the second law of thermodynamics", "collision model". (6 %)
2. An inverse concentration dependence on one of the species taking part in the reaction. Explain the meaning of it. (4 %)
3. A 1.00L solution was made from dissolving 20g of NaCl in enough water. Assume that the density of the solution is  $1.00 \text{ g/cm}^3$ . Please calculate the molality, molarity and mole fraction of NaCl of this solution. Suppose sodium chloride dissociates completely in aqueous solution, please calculate the boiling point and freezing point of this solution. ( $K_b = 0.51^\circ\text{C Kg/mol}$ ;  $K_f = 1.86 \text{ Kg/mol}$  for water, NaCl:  $58.44 \text{ g/mol}$ ;  $\text{H}_2\text{O} = 18.0 \text{ g/mol}$ ) (10%)
4. The best laboratory vacuum system can pump down to as few as  $1.0 \times 10^9$  molecules per cubic meter of gas. Calculate the corresponding pressure, in atmospheres, assuming a temperature of  $0^\circ\text{C}$ . (10%)
5. Answer the following questions about the Lewis Acid boron trifluoride.
  - (1) Draw the Lewis Structure of boron trifluoride. (3 %)
  - (2) Draw a VSEPR diagram of boron trifluoride. Label the bond angles. (3 %)
  - (3) Is this molecule polar? Draw all bond dipoles and explain. (4 %)

二、請將選擇題之最適答案作答於答案卡上(單選題，每題 3 分，共 20 題)

1. Which one of the following statements about transition metal species is incorrect?
  - (A)  $\text{TiCl}_4$  is an ionic compound
  - (B)  $\text{MnO}$  is a basic oxide
  - (C)  $\text{CrO}_3$  is an acidic oxide
  - (D)  $\text{ZnCl}_4^{2-}$  is colorless
2. The average mass of a boron atom is 10.81. If you were able to isolate a single boron atom, what is the chance that you would randomly get an atom with mass 10.81?
  - (A) 0% (B) 0.81% (C) about 11% (D) 10.81%
3. The compound 2-germaacetic ( $\text{GeH}_3\text{COOH}$ ) is an unstable weak acid. At  $25^\circ\text{C}$ , a 0.050 M solution of 2-germaacetic acid has a pH of 2.42. Determine the  $K_a$  of 2-germaacetic acid.
  - (A)  $3.12 \times 10^{-4}$  (B) 0.076 (C) 2.42 (D) 0.38
4. Which one of the following statements is incorrect?
  - (A)  $IE_1: \text{P} > \text{Al} > \text{Na}$
  - (B)  $EN: \text{Cl} > \text{Se} > \text{Br}$
  - (C) Atomic size:  $\text{Si} > \text{P} > \text{N}$
  - (D) Number of valence electrons:  $\text{S} > \text{Sb} > \text{Cs}$
5. The reaction,  $2\text{A} + \text{B} \rightarrow \text{C}$ , has the following proposed mechanism:  
Step 1:  $\text{A} + \text{B} \rightarrow \text{D}$  (fast equilibrium)  
Step 2:  $\text{D} + \text{B} \rightarrow \text{E}$   
Step 3:  $\text{E} + \text{A} \rightarrow \text{C} + \text{B}$   
If step 2 is the rate-determining step, then the rate of formation of C should equal:
  - (A)  $k[\text{A}]$
  - (B)  $k[\text{A}]^2[\text{B}]$
  - (C)  $k[\text{A}]^2[\text{B}]^2$
  - (D)  $k[\text{A}][\text{B}]^2$
6. Which of the following species can function as an enzyme in organisms?
  - (A) DNA (B) protein (C) cellulose (D) fatty acids

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7. The indicator cresol red has  $K_a=5.0 \times 10^{-9}$ . Over what proximate pH range does it change color? (A) 7.3 — 9.3 (B) 4.3 — 6.3 (C) 8.3 — 10.3 (D) 6.3 — 8.3
8. Calculate the wavelength, in nanometers, of an x-ray that has frequency of  $5.15 \times 10^{16} \text{ s}^{-1}$ . (A) 5.83 nm (B) 17.2 nm (C) 583 nm (D) 0.172 nm
9. The best explanation for the fact that oxygen forms only  $\text{OF}_2$  with fluorine, while sulfur forms  $\text{SF}_2$ ,  $\text{SF}_4$  and  $\text{SF}_6$ , is that  
(A) oxygen is more electronegative than sulfur.  
(B) sulfur is less electronegative than oxygen.  
(C) oxygen is smaller than sulfur.  
(D) sulfur has d orbitals available for bonding.
10. A stock bottle of nitric acid indicates that the solution is 67.0%  $\text{HNO}_3$  by mass and has a density of 1.40 g/mL. Calculate the molarity of the solution. (H=1.00, N=14.0, O=16.0)  
(A) 22.2 (B) 14.9 (C) 10.6 (D) 0.0148
11. If the half life of a reaction with respect to a reactant concentration is  $0.693/k$ , what is the reaction order of the reactant? (A) First order (B) Second order (C) Third order (D) Zero order.
12. A carbon that has four different groups attached to it is a \_\_\_\_ carbon?  
(A) chimerical (B) typical (C) phospholipids (D) chiral
13. If an endothermic reaction is spontaneous at 298 K, which of the following must be true for the reaction?  
I.  $\Delta G$  is greater than zero.  
II.  $\Delta H$  is greater than zero.  
III.  $\Delta S$  is greater than zero.  
(A) I only (B) II only (C) I and II only (D) II and III only
14. Compound  $\text{X}_2\text{Y}$  is 60% X by mass. Calculate the percent Y by mass of the compound  $\text{X}_2\text{Y}_2$ .  
(A) 20% (B) 30% (C) 40% (D) 60%
15. Calculate  $\Delta G$  for the isothermal compression of 1 mol of an ideal monatomic gas from 1.4 atm to 5.6 atm at  $23^\circ\text{C}$ .  
(A)  $3.4 \times 10^3 \text{ J}$  (B)  $1.6 \times 10^3 \text{ J}$  (C)  $-3.4 \times 10^3 \text{ J}$  (D)  $-1.6 \times 10^3 \text{ J}$
16. How many electrons in an atom can have the quantum numbers  $n=3, l=1$ ?  
(A) 10 (B) 2 (C) 6 (D) 18
17. Please order the  $K_a$  values for a series of oxyacids:  $\text{HOCl}$ ,  $\text{HOBr}$ ,  $\text{HOI}$ ,  $\text{HOCH}_3$ .  
(A)  $\text{HOI} > \text{HOBr} > \text{HOCl} > \text{HOCH}_3$   
(B)  $\text{HOCH}_3 > \text{HOI} > \text{HOBr} > \text{HOCl}$   
(C)  $\text{HOCH}_3 > \text{HOCl} > \text{HOBr} > \text{HOI}$   
(D)  $\text{HOCl} > \text{HOBr} > \text{HOI} > \text{HOCH}_3$
18. The percent dissociation in a 0.10 M aqueous solution of monoprotic acid is 2.5%. Please calculate the value of  $K_a$  for this acid. (A)  $1.23 \times 10^{-4}$  (B)  $2.5 \times 10^{-3}$  (C)  $6.4 \times 10^{-5}$   
(D)  $7.4 \times 10^{-6}$

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19. Which of the following is state function?

(A) work (B) heat (C) enthalpy (D) none of these

20. The half-life of a radioactive nuclide is 14 hours. Without doing calculations, how long would it take for a sample to decay to 12% of its present activity? (A) 3 hours (B) 14 hours (C) 28 hours (D) 42 hours