

# 中山醫學大學 100 學年度碩士班入學招生考試試題

口腔科學研究所碩士班 (甲組)

考試科目：普通化學

時間：80 分鐘

※請注意本試題共( 4 )張，如發現頁數不足，應當場請求補齊，否則缺頁部份概以零分計算。第 ( / ) 頁

本試題共 2 大題，總分 100 分。

一、單擇題：(每題 3 分) (90%)

1. What is the correct formula for chromium (III) oxide? (A) CrO (B) Cr<sub>3</sub>O<sub>2</sub> (C) Cr<sub>3</sub>O (D) Cr<sub>2</sub>O<sub>3</sub> (E) CrO<sub>2</sub>
2. For which of the following compounds does 1.0 g represent  $5.9 \times 10^{-2}$  moles (C = 12, O = 16, N = 14)? (A) CO<sub>2</sub> (B) NH<sub>3</sub> (C) H<sub>2</sub>O (D) all (E) none
3. Which of the following statements about atomic structure is FALSE?  
(A) The electrons occupy a very large volume compared to the nucleus.  
(B) Almost all of the mass of the atom is concentrated in the nucleus.  
(C) The protons and neutrons in the nucleus are very tightly packed.  
(D) The number of protons and neutrons is always the same in a neutral atom
4. A 20 g of HF (F = 19) is dissolved in water to give 200 mL of solution. What is the concentration of the solution? (A) 1 M (B) 3 M (C) 0.1 M (D) 10 M (E) 5 M
5. In the reaction  $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$ , which, if any, element is oxidized?  
(A) Zn (B) H (C) S (D) O (E) none is oxidized
6. Which statement is TRUE?  
(A) When two opposing processes proceed at identical rates, the system is at equilibrium.  
(B) Catalysts shift the position of equilibrium.  
(C) The concentration of the products equals that of the reactants and both are constant at equilibrium.  
(D) An endothermic reaction shifts toward reactants when heat is applied.  
(E) None of the above
7. Which of the following pairs of compounds can be used to illustrate the law of multiple proportions? (A) NH<sub>4</sub> and NH<sub>4</sub>Cl (B) ZnO<sub>2</sub> and ZnCl<sub>2</sub> (C) H<sub>2</sub>O and HCl (D) NO and NO<sub>2</sub> (E) CH<sub>4</sub> and CO<sub>2</sub>
8. Which of the following statements about quantum theory is FALSE?  
(A) The energy and position of an electron cannot be determined simultaneously.  
(B) Lower energy orbitals are filled with electrons before higher energy orbitals.  
(C) When filling orbitals of equal energy, two electrons occupy the same orbital before filling a new orbital.  
(D) No two electrons can have the same four quantum numbers.  
(E) None of these.

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9. Atoms with greatly differing electronegativities are expected to form (A) no bonds. (B) polar covalent bond. (C) nonpolar covalent bond. (D) ionic bonds. (E) covalent bonds.
10. A steel tank containing oxygen gas is heated slightly. As it is heated, the density of the oxygen gas (A) increases. (B) decreases. (C) stays the same.
11. When the reaction  $\text{PCl}_{5(g)} \rightleftharpoons \text{PCl}_{3(g)} + \text{Cl}_{2(g)}$  is at equilibrium and more reactant is added to the container,  
(A) the forward reaction rate increases.  
(B) the reverse reaction rate increases.  
(C) the forward reaction rate decreases.  
(D) the equilibrium remains unchanged.  
(E) the equilibrium constant increases.
12. What is the  $\text{H}^+$  concentration of 0.1 M acetic acid and 0.2 M sodium acetate? ( $K_a = 1.8 \times 10^{-5}$  for acetic acid) (A)  $1.8 \times 10^{-5}$  M (B) 0.1 M (C)  $1.3 \times 10^{-3}$  M (D)  $9 \times 10^{-6}$  M (E) none of these
13. The density of a solution containing 296.6 g of  $\text{Mg}(\text{NO}_3)_2$  per liter is 1.114 g/mL. The molarity of the solution is (A) 2.00 M (B) 2.44 M (C) 6.00 M (D) 1.81 M (E) none of these ( $\text{Mg} = 24.3, \text{N} = 14.0, \text{O} = 16.0$ )
14. Under which conditions must a reaction be spontaneous at all temperatures?  
(A)  $\Delta H$  is positive,  $\Delta S$  is positive.  
(B)  $\Delta H = 0$ ,  $\Delta S$  is negative.  
(C)  $\Delta S = 0$ ,  $\Delta H$  is positive.  
(D)  $\Delta H$  is negative,  $\Delta S$  is positive.  
(E) None of these
15. The standard potential for the reaction of hydrogen and oxygen is  $E^0 = +1.23$  V.  
$$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$$
  
What is the standard potential for the following reaction:  
$$\text{H}_2\text{O} \rightarrow \text{H}_2 + 1/2 \text{O}_2$$
  
(A) 1.23 V (B) 0.625V (C) -0.625V (D) -1.23V (E) -2.46 V
16. When the equation  $\text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$  is balanced with the smallest set of integers, what is the sum of the coefficients? (A) 4 (B) 28 (C) 33 (D) 15 (E) 30
17. With what volume of 5.0 M HF does 4.0 g of calcium react completely, according to the reaction  $\text{Ca} + 2\text{HF} \rightarrow \text{CaF}_2 + \text{H}_2$ ? ( $F = 19, \text{Ca} = 40$ ) (A) 20.0 mL (B) 50.0 mL (C) 30.0 mL (D) 40.0 mL (E) 100.0 mL

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18. As water is heated, its pH decreases. Which is TRUE? (A) The water is no longer neutral. (B)  $[H^+] > [OH^-]$  (C)  $[H^+] < [OH^-]$  (D) A and B are correct (E) none of these.
19. Identify the Bronsted acids and bases in the following equation (X = Bronsted acids, Y = Bronsted base):
- $$HSO_3^- + CN^- \rightleftharpoons HCN + SO_3^{2-}$$
- (A) Y      X      Y      X  
(B) Y      Y      X      X  
(C) X      Y      X      Y  
(D) X      Y      Y      X  
(E) Y      X      X      Y
20. For which process is  $\Delta S$  negative?  
(A) evaporation of 1 mol of  $CCl_4(l)$   
(B) mixing 5 mL ethanol with 25 mL water  
(C) compressing 1 mol He at constant temperature from 1.5 atm to 0.5 atm  
(D) raising the temperature of 100 g Cu from 275 K to 295 K  
(E) grinding a large crystal of KCl to powder
21. A certain reaction has  $\Delta H_{rxn}^0 = +177.8 \text{ kJ}$ , and  $\Delta S_{rxn}^0 = +160.5 \text{ J/K}$ . Above what temperature does it become product-favored? (A)  $384^\circ\text{C}$  (B)  $630^\circ\text{C}$  (C)  $1108.5^\circ\text{C}$  (D)  $835^\circ\text{C}$  (E)  $1381^\circ\text{C}$
22. Which of the following molecules contains the shortest C-C bond? (A)  $C_2H_2$  (B)  $C_2H_4$  (C)  $C_2H_6$  (D)  $C_2Cl_4$  (E) B and D
23. What volume of 12.0 M nitric acid is required to prepare 6.00 L of 0.100 M nitric acid? (A) 1.20 L (B) 1.00 L (C) 0.500 L (D) 0.0500 L (E) 0.0200 L
24. Four identical 1.0-L flasks contain the gases He,  $Cl_2$ ,  $CH_4$ , and  $NH_3$ , each at  $0^\circ\text{C}$  and 1 atm pressure. Which gas has the highest density (He = 4, Cl = 37.5, N = 14)? (A) He (B)  $Cl_2$  (C)  $CH_4$  (D)  $NH_3$  (E) all gases the same.
25. The structures of proteins are partially determined by the order of the amino acids in the micromolecule. This level of structural determination is (A) primary structure. (B) secondary structure. (C) tertiary structure. (D) quaternary structures. (E) the order of bases.
26. The average rate of disappearance of ozone (臭氧) in the reaction  $2O_{3(g)} \rightarrow 3O_{2(g)}$  is  $9.0 \times 10^{-3} \text{ atm/s}$ . What is the rate of production of  $O_2$ ? (A)  $1.3 \times 10^{-2}$  (B)  $9.0 \times 10^{-3}$  (C)  $6.0 \times 10^{-3}$  (D)  $3.0 \times 10^{-5}$  (E)  $2.7 \times 10^{-5} \text{ atm/s}$

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27. Which is the most basic oxide in aqueous solution? (A) BeO (B) CO<sub>2</sub> (C) BaO (D) SO<sub>3</sub> (E) Al<sub>2</sub>O<sub>3</sub>
28. Which of the following is NOT determined by the principal quantum number n of the electron in a hydrogen atom?  
(A) the energy of the electron  
(B) the minimum wavelength of the light needed to remove the electron from the atom  
(C) the size of the corresponding atomic orbital(s)  
(D) the shape of the corresponding atomic orbital(s)  
(E) all of these are determined by n
29. For the elements Cs, F, and Cl, the order of increasing electronegativity is  
(A) F < Cl < Cs (B) Cs < Cl < F (C) Cl < Cs < F (D) F < Cs < Cl (E) none of these.
30. Which of the following is most likely to be a solid at room temperature? (A) Na<sub>2</sub>S (B) HF (C) NH<sub>3</sub> (D) N<sub>2</sub> (E) H<sub>2</sub>O

二、計算題：(每題 5 分)(10%)

1. Calculate the pH of a 1 M nitric acid (HNO<sub>3</sub>) solution.

2. Given:  $\text{Cl}_{2(g)} + 2e^- \rightarrow 2\text{Cl}^-_{(aq)}$   $E^\circ = 1.360 \text{ V}$

$\text{I}_{2(s)} + 2e^- \rightarrow 2\text{I}^-_{(aq)}$   $E^\circ = 0.536 \text{ V}$

Use the half-reaction potential to determine whether the following proposed reaction is spontaneous with all substances at unit activity:  $\text{Cl}_{2(g)} + 2\text{I}^-_{(aq)} \rightarrow 2\text{Cl}^-_{(aq)} + \text{I}_{2(s)}$