

110BE02

## 國立臺北科技大學 110 學年度碩士班招生考試

系所組別：3602

化學工程與生物科技系生化與生醫工程碩士班

第一節 普通化學 試題 (選考)

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## 注意事項：

1. 本試題共 40 題，每題 2.5 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. What is the correct name for this compound with the formula  $Mg_3(PO_4)_2$ ?  
(A) trimagnesium diphosphate (B) magnesium(II) phosphate  
(C) magnesium(II) diphosphate (D) magnesium phosphate  
(E) magnesium(III) diphosphate
2. According to the rules for naming compounds, which of the following compounds is correctly named?  
(A)  $PbO$ , lead(IV) oxide (B)  $Al_2S_3$ , dialuminum trisulfide (C)  $Li_2O$ , lithium oxide  
(D)  $N_2O$ , nitrogen oxide (E)  $CO$ , carbon dioxide
3. How many protons, neutrons, and electrons are in  $^{59}_{27}Co^{2+}$ ?  
(A) 25 protons, 32 neutrons, 27 electrons (B) 27 protons, 25 neutrons, 32 electrons  
(C) 25 protons, 27 neutrons, 32 electrons (D) 27 protons, 32 neutrons, 25 electrons  
(E) 32 protons, 27 neutrons, 30 electrons
4. A compound contains 49.48% C, 5.15% H, 16.50% O, and 28.87% N by mass. What is the empirical formula of this compound?  
(A)  $C_4H_5N_2O$  (B)  $C_6H_5O_3N$  (C)  $C_{11}H_{19}O_7N$  (D)  $C_4H_8O_3N$  (E)  $C_8H_{11}N_3O$
5. What is the sodium ion concentration when 70.0 ml of 0.3 M sodium carbonate is added to 30.0 mL of 0.1 M sodium bicarbonate?  
(A) 0.15 M (B) 0.25 M (C) 0.35 M (D) 0.45 M (E) 0.55 M
6. At a temperature, a 5 liter flask contains 5 moles of  $Cl_2$  gas, 1.5 mole of  $NOCl$  gas, and  $7.5 \times 10^{-3}$  mole of  $NO$  gas at chemical equilibrium. What is the  $K_c$  for the following reaction?  
 $2NOCl(g) \rightarrow 2NO(g) + Cl_2(g)$   
(A)  $1.25 \times 10^{-5}$  (B)  $1.5 \times 10^{-5}$  (C)  $1.75 \times 10^{-5}$  (D)  $2.0 \times 10^{-5}$  (E)  $2.5 \times 10^{-5}$
7. At 25°C, what is the pH of  $1 \times 10^{-4}$  M NaOH aqueous solution?  
(A) 4 (B) 7 (C) 10 (D) 12 (E) 14
8. What is the percent dissociation of 0.5 M acetic acid at 25°C? (at 25°C acetic acid  $K_a = 1.8 \times 10^{-5}$ )  
(A) 0.2% (B) 0.4% (C) 0.6% (D) 0.8% (E) 1.0%
9. At 25°C, which of the following substance has a standard enthalpy of formation equal to zero?  
(A)  $O_2(g)$  (B)  $H_2O(g)$  (C)  $CH_4(g)$  (D)  $Cl(g)$  (E)  $CO(g)$
10. Which of the following is the electron configuration for an atom of sulfur?  
(A)  $1s^2 2s^2 2p^6 3s^2 3p^4$   
(B)  $1s^2 2s^2 2p^6 3s^2 3p^5$   
(C)  $1s^2 2s^2 2p^6 3s^2 3p^4 s^1$   
(D)  $1s^2 2s^2 2p^6 3s^2 3p^4 s^2$   
(E)  $1s^2 2s^2 2p^6 3s^2 3p^4 s^2 4p^4$
11. Which of the following is the electron configuration for an atom of Iron?  
(A)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$   
(B)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$   
(C)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$   
(D)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^6$   
(E)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6 3d^6$
12. An aqueous solution is prepared by adding 50.0 mL of 0.050 M HBr aqueous solution to 150.0 mL of 0.10 M HI aqueous solution. Calculate the  $[H^+]$  of this aqueous solution(M)? (HBr and HI are both considered strong acids)  
(A) 0.022 (B) 0.044 (C) 0.066 (D) 0.088 (E) 0.11
13. Ascorbic acid, or vitamin C ( $C_6H_8O_6$ ), is an essential vitamin. If a typical tablet contains 500.0 mg vitamin C, what amount (moles) of vitamin C is contained in 5 tablets?  
(A)  $1.4 \times 10^{-3}$  (B)  $2.8 \times 10^{-3}$  (C)  $1.4 \times 10^{-2}$  (D)  $2.8 \times 10^{-2}$  (E) 0.14
14. At temperature 1000 K, equilibrium constant  $K_p = 0.25$  for the reaction  $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ . What is the value of equilibrium constant  $K(K_c)$  at this temperature?  
(A) 10.3 (B) 20.5 (C) 30.1 (D) 40.1 (E) 50.2
15. A buffered solution is made by adding 40.1 g  $NH_4Cl$  to 1.00 L of a 0.75 M solution of  $NH_3$ . Calculate the pH of the final solution. (Assume no volume change.) ( $NH_4^+$   $K_a = 5.6 \times 10^{-10}$ )  
(A) 8.25 (B) 9.25 (C) 10.25 (D) 11.25 (E) 12.25
16. Which of the following is optically active (i.e., chiral)?  
(A)  $HN(CH_3)_2$  (B) 2-chlorobutane (C)  $CH_2Cl_2$   
(D) 2-chloropropane (E) 3-chloropentane
17. What might be the product of the oxidation of secondary alcohol?  
(A) ether (B) tertiary alcohol (C) aldehyde (D) ester (E) ketone
18. What is the most abundant (by mass) element found in the human body?  
(A) carbon (B) hydrogen (C) calcium (D) oxygen (E) water
19. Which of the following would you expect to have the lowest vapor pressure at 25°C?  
(A)  $CH_3OCH_3$  (B)  $CH_3CH_2OH$  (C)  $CH_3CH_2CH_3$   
(D)  $CH_3CH_2CH_2CH_3$  (E)  $H_2O$
20. For a zero-order reaction  
 $aA \rightarrow \text{Products}$   
the first half-life is 20 minutes. What is the second half-life?  
(A) 2.5 minutes (B) 5 minutes (C) 10 minutes (D) 20 minutes (E) 40 minutes

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21. The reaction  $2A + B \rightarrow C$  has the following proposed mechanism.
- step 1:  $A + B \rightleftharpoons D$  (fast equilibrium)  
 step 2:  $D + B \rightarrow E$   
 step 3:  $E + A \rightarrow C + B$
- 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)  $k[A]^2[B]^2$
22. Which of the following is diamagnetic?  
 (A)  $N_2$  (B)  $N_2^+$  (C)  $O_2$  (D)  $N_2^-$  (E)  $O_2^+$
23. Which of the following statements is true?  
 (A) a triple bond is composed of two  $\sigma$  bonds and one  $\pi$  bond.  
 (B)  $\sigma$  bonds result from the head-to-head overlap of atomic orbitals.  
 (C) Free rotation may occur about a double bond.  
 (D)  $\pi$  bonds have electron density on the internuclear axis.  
 (E) the Lewis structure for  $C_2H_2$  shows single bonds and one double bond.
24. Which of the following statements best describes  $BF_3$  and  $NF_3$ ? (Note: Geometry refers to the electron pair arrangement, and shape refers to the atom arrangement.)  
 (A) they have variable geometries and shapes due to their potential resonance structures.  
 (B) they have the same geometry and different shapes.  
 (C) they have the same geometry and the same shape.  
 (D) they have different geometries and different shapes.  
 (E) they have different geometries and the same shape.
25. Which of the following molecules has a dipole moment?  
 (A)  $SF_4$  (B)  $CF_4$  (C)  $XeF_4$  (D)  $SF_6$  (E)  $XeF_2$
26. How many resonance structures does the  $NO_3^-$  have?  
 (A) 0 (B) 1 (C) 2 (D) 3 (E) 4
27. The first ionization energy of magnesium is approximately 700 kJ/mol. What is a good estimate for the second ionization energy (kJ/mol) of magnesium?  
 (A) -700 (B) 700 (C) -1400 (D) 1400 (E) 70,000
28. For any operating concentration cell, which of the following statements is true?  
 (A)  $E$  and  $E^\circ$  must both be positive.  
 (B)  $E$  must be zero and  $E^\circ$  must be positive  
 (C)  $E^\circ$  must be zero and  $E$  must be positive.  
 (D)  $E$  and  $E^\circ$  must both be negative.  
 (E)  $E^\circ$  must be positive and  $E$  must be negative.
29. For any galvanic cell to operate, which of the following statements is true?  
 (A)  $\Delta G^\circ$  and  $E^\circ$  must both be positive.  
 (B)  $\Delta G^\circ$  must be negative and  $E^\circ$  must be positive.  
 (C)  $\Delta G^\circ$  and  $E^\circ$  must both be negative.  
 (D)  $\Delta G^\circ$  must be positive and  $E^\circ$  must be negative.  
 (E)  $\Delta G^\circ$  must be zero and  $E^\circ$  must be negative.
30. In which case must a reaction be spontaneous at all temperatures?  
 (A)  $\Delta H$  is positive, and  $\Delta S$  is positive.  
 (B)  $\Delta H$  is negative, and  $\Delta S$  is negative.  
 (C)  $\Delta H$  is positive, and  $\Delta S$  is negative.  
 (D)  $\Delta H$  is negative, and  $\Delta S$  is positive.  
 (E)  $\Delta H = 0$ , and  $\Delta S = 0$ .
31. Which is the percent dissociation of HF in a solution containing both 1.0 M HF and 1.0 M NaF? (HF  $K_a = 7.2 \times 10^{-4}$ ).  
 (A) 0.072% (B) 0.27% (C) 0.72% (D) 2.7% (E) 7.2%
32. Which is the mathematical expression of solubility product ( $K_{sp}$ ) for the molar solubility ( $S$ ) in (mol/L) of  $Fe_3(PO_4)_2$ ?  
 (A)  $S^2$  (B)  $6S^2$  (C)  $12S^3$  (D)  $6S^5$  (E)  $108S^5$
33. Consider a solution made by mixing 500.0 mL of 4.0 M  $NH_3$  and 500.0 mL of 0.20 M  $AgNO_3$ .  $Ag^+$  reacts with  $NH_3$  to form  $AgNH_3^+$  and  $Ag(NH_3)_2^+$ :  
 $Ag^+ + NH_3 \rightleftharpoons AgNH_3^+ \quad K_1 = 2.1 \times 10^3$   
 $AgNH_3^+ + NH_3 \rightleftharpoons Ag(NH_3)_2^+ \quad K_2 = 8.2 \times 10^3$   
 Which is the concentration of  $Ag(NH_3)_2^+$  at equilibrium?  
 (A) 0.4 M (B) 0.20 M (C) 0.10 M (D)  $4.1 \times 10^{-3}$  M (E)  $1.05 \times 10^{-3}$  M
34. Calculate the  $[H^+]$  of a 1.0 M  $H_2SO_4$  aqueous solution? ( $H_2SO_4$   $K_{a2} = 1.2 \times 10^{-2}$ )  
 (A) 2.024 M (B) 2.0 M (C) 1.24 M (D) 1.012 M (E)  $1.2 \times 10^{-2}$  M
35. At 25°C, the equilibrium constant for  $A + 2B \rightleftharpoons 3C$  is  $1.0 \times 10^{-6}$ . Which is the equilibrium constant for  $6C \rightleftharpoons 2A + 4B$  at same temperature?  
 (A)  $1.0 \times 10^{-12}$  (B)  $1.0 \times 10^{-6}$  (C)  $2.0 \times 10^{-6}$  (D)  $1.0 \times 10^6$  (E)  $1.0 \times 10^{12}$
36. Consider a chemical system at equilibrium. The reaction is endothermic process and the temperature of the system is raised. Which of the following is true? ( $K$  is equilibrium constant)  
 (A) equilibrium shifts to the left and the value of  $K$  increases  
 (B) equilibrium shifts to the right and the value of  $K$  increases  
 (C) equilibrium shifts to the right and the value of  $K$  decreases  
 (D) equilibrium shifts to the left and the value of  $K$  decreases  
 (E) equilibrium shifts, but the value of  $K$  stays constant.
37. Which of the following coordination compounds will most easily form a precipitate when treated with an aqueous solution of  $AgNO_3$ ?  
 (A)  $[Cr(NH_3)_3Cl_3]$  (B)  $[Cr(NH_3)_5Cl](NO_3)_2$  (C)  $[Cr(NH_3)_6]Cl_3$   
 (D)  $Na_3[Cr(CN)_6]$  (E)  $Na_3[CrCl_6]$
38. Which ions are very important for the proper functioning of biologic systems, such as nerves and muscles?  
 (A) alkali metal ions (B) alkaline earth metal ions (C) oxygen ions  
 (D) sulfur ions (E) nitrogen ions
39. What is the general formula for superoxides?  
 (A)  $MO$  (B)  $M_2O_2$  (C)  $M_2O$  (D)  $M_2O_3$  (E)  $MO_2$
40. Which of the following 0.05 M aqueous solutions is expected to exhibit the greatest ion pairing?  
 (A) NaCl (B)  $MgCl_2$  (C) HCl (D)  $FeCl_3$  (E) glucose