

# 國立中正大學九十二學年度碩士班招生考試試題

系所別：化學暨生物化學系

科目：一般化學

第 1 頁，共 6 頁

科目：一般化學

本試題共 50 題單一選擇題，每題 2 分，滿分 100 分。答錯不倒扣。請將答案依序寫在答案卷上。

- Which of the following atomic symbols is not correct?  
(A)  ${}^1_6\text{C}$  (B)  ${}^{37}_{17}\text{Cl}$  (C)  ${}^{32}_{15}\text{P}$  (D)  ${}^{39}_{19}\text{K}$  (E)  ${}^{14}_8\text{N}$
- Which of the following element is the transition metal?  
(A) Rn (B) Co (C) Br (D) Ca (E) Sn
- What mass of styrene (molar mass 104.1 g/mol) contains  $4.50 \times 10^{20}$  molecules of styrene?  
(A)  $7.48 \times 10^{-4}$  g (B)  $7.48 \times 10^{-3}$  g (C)  $7.78 \times 10^{-2}$  g  
(D)  $7.78 \times 10^{-3}$  g (E)  $7.48 \times 10^4$  g
- Sulfuric acid may be prepared by the following process:  
$$4\text{FeS}_2 + 11\text{O}_2 \longrightarrow 2\text{Fe}_2\text{O}_3 + 8\text{SO}_2$$
$$2\text{SO}_2 + \text{O}_2 \longrightarrow 2\text{SO}_3$$
$$\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$$
How many moles of  $\text{H}_2\text{SO}_4$  are produced from 5.00 moles of  $\text{FeS}_2$ ?  
(A) 6.11 (B) 5.00 (C) 7.50 (D) 10.0 (E) 20.0
- One mole of each of the following compounds is added to water in separate flasks to make 1.0 L of solution. Which solution has the largest total ion concentration?  
(A) calcium carbonate (B) potassium phosphate (C) aluminum hydroxide  
(D) silver chloride (E) sodium chloride
- What volume of 0.250 M  $\text{H}_2\text{SO}_4$  is required to react completely with 25.0 mL of 1.500 M NaOH?  
(A) 150.0 mL (B) 50.0 mL (C) 300.0 mL (D) 75.0 mL (E) none of these
- Calculate the density of nitrogen gas at STP. (atomic weight of nitrogen: 14.0)  
(A) 0.312 g/L (B) 0.625 g/L (C) 0.800 g/L (D) 1.25 g/L (E) 1.60 g/L
- A 250.0-L cylinder contains 65.0%  $\text{He}_{(g)}$  and 35.0%  $\text{Kr}_{(g)}$  by volume at  $25.0^\circ\text{C}$  and 1.35 atm total pressure. What is the partial pressure of He in this container?  
(A) 0.473 atm (B) 0.675 atm (C) 0.878 atm (D) 1.32 atm (E) 1.35 atm
- Which of the following statements is true for ideal gases?  
(A) The temperature of the gas sample is directly related to the average velocity of the gas particles.  
(B) A gas exerts pressure because its molecules collide with the walls of the container.  
(C) At STP, 1.0 L of  $\text{Ar}_{(g)}$  contains about twice the number of atoms as 1.0 L of  $\text{Ne}_{(g)}$  because the molar mass of Ar is about twice that of Ne.  
(D) The gas particles in a sample attract each other.  
(E) None of the above.

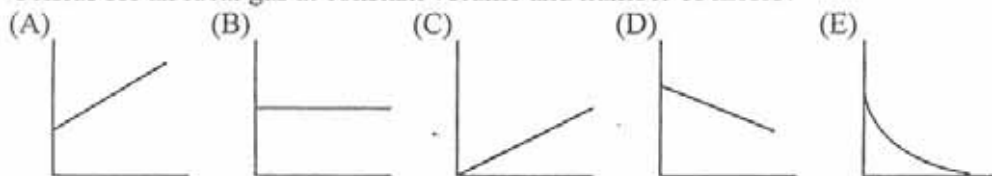
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10. Which of the following graphs represents the plot of pressure vs. temperature in degree Celsius for an ideal gas at constant volume and number of moles?



11. Which of the following statements about the equilibrium is true?  
 (A) Catalysts shift the position of an equilibrium.  
 (B) The equilibrium constant is independent of temperature.  
 (C) When two opposing processes proceed at identical rates, the system is at equilibrium.  
 (D) The concentration of the products equals that of the reactants and both are constant at equilibrium.  
 (E) An endothermic reaction shifts toward reactants when heat is applied.

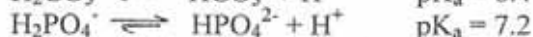
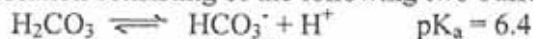
12. A sample of solid  $\text{NH}_4\text{NO}_3$  was placed in an evacuated container and heated so that it decomposed explosively according to the following reaction:



At equilibrium the total pressure in the container is 3.20 atm at  $500^\circ\text{C}$ . Calculate  $K_p$ .

- (A)  $3.10 \text{ atm}^3$  (B)  $1.23 \text{ atm}^3$  (C)  $2.56 \text{ atm}^2$  (D)  $4.87 \text{ atm}^3$  (E)  $1.14 \text{ atm}^2$
13. The following acids are listed in the order of decreasing acid strength in water:  
 $\text{HI} > \text{HNO}_2 > \text{CH}_3\text{COOH} > \text{HClO} > \text{HCN}$ .  
 According to Brønsted-Lowry theory, which of the following ions is the weakest base?  
 (A)  $\text{I}^-$  (B)  $\text{NO}_2^-$  (C)  $\text{CH}_3\text{COO}^-$  (D)  $\text{ClO}^-$  (E)  $\text{CN}^-$
14. For nitrous acid,  $\text{HNO}_2$ ,  $K_a = 4.0 \times 10^{-4}$ . Calculate the pH of 0.25 M  $\text{HNO}_2$ .  
 (A) 2.00 (B) 2.30 (C) 2.70 (D) 3.70 (E) none of these.

15. Consider a solution consisting of the following two buffer systems:



At pH 6.4, how do the amounts of acid and conjugate base compare?

- (A)  $[\text{H}_2\text{CO}_3] > [\text{HCO}_3^-]$  and  $[\text{H}_2\text{PO}_4^-] > [\text{HPO}_4^{2-}]$   
 (B)  $[\text{H}_2\text{CO}_3] = [\text{HCO}_3^-]$  and  $[\text{H}_2\text{PO}_4^-] > [\text{HPO}_4^{2-}]$   
 (C)  $[\text{H}_2\text{CO}_3] = [\text{HCO}_3^-]$  and  $[\text{H}_2\text{PO}_4^-] < [\text{HPO}_4^{2-}]$   
 (D)  $[\text{H}_2\text{CO}_3] > [\text{HCO}_3^-]$  and  $[\text{H}_2\text{PO}_4^-] < [\text{HPO}_4^{2-}]$   
 (E)  $[\text{H}_2\text{CO}_3] < [\text{HCO}_3^-]$  and  $[\text{H}_2\text{PO}_4^-] < [\text{HPO}_4^{2-}]$
16. Buffers in the human body  
 (A) help to maintain a constant blood pH.  
 (B) help to keep the body temperature constant.  
 (C) help change the blood plasma pH when foods are eaten.  
 (D) precipitate proteins so enzyme are inactive. (E) none of these.

17. Consider a solution made by mixing 500.0 mL of 4.0 M  $\text{NH}_3$  and 500.0 mL of 0.4 M  $\text{AgNO}_3$ .  $\text{Ag}^+$  reacts with  $\text{NH}_3$  to form  $[\text{Ag}(\text{NH}_3)_2]^+$ :  
 $\text{AgNH}_3^+ + 2\text{NH}_3 \rightleftharpoons [\text{Ag}(\text{NH}_3)_2]^+ \quad K = 1.72 \times 10^7$   
 What is the concentration of  $\text{Ag}^+$  at equilibrium?  
 (A) 2.0 M (B)  $1.2 \times 10^{-8}$  M (C)  $2.2 \times 10^{-9}$  M  
 (D) 1.6 M (E)  $4.5 \times 10^{-9}$  M



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18. 30.0 mL of pure water at 280 K is mixed with 50.0 mL of pure water at 330 K. What is the final temperature of the mixture?  
 (A) 290 K (B) 311 K (C) 320 K (D) 326 K (E) 405 K
19. When 0.157 mol  $\text{NH}_3$  reacts with excess HCl, 6.91 kJ of energy is released as heat. What is  $\Delta H$  for this reaction per mole of  $\text{NH}_3$  consumed?  
 (A) -22.7 J (B) -1.08 kJ (C) -44.0 kJ (D) +22.7 J (E) +44.0 kJ
20. Using the following data to calculate  $\Delta H^\circ_{f(298)}$  for  $\text{AgI}_{(s)}$ .  

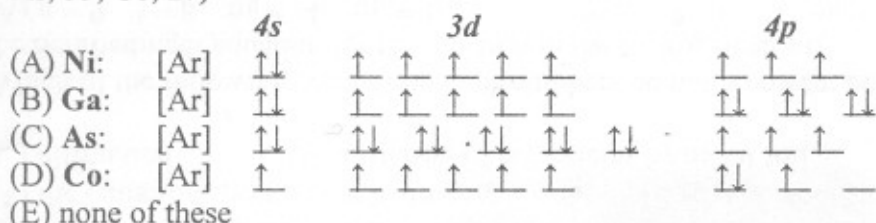
$$\text{AgI}_{(s)} + 1/2 \text{Br}_{2(g)} \longrightarrow \text{AgBr}_{(s)} + 1/2 \text{I}_{2(s)} \quad \Delta H^\circ_f = -54.0 \text{ kJ}$$

$$\Delta H^\circ_f \text{ for } \text{AgBr}_{(s)} = -100.4 \text{ kJ/mol} \quad \Delta H^\circ_f \text{ for } \text{Br}_{2(g)} = +30.9 \text{ kJ/mol}$$
 (A) -123.5 kJ/mol (B) +77.3 kJ/mol (C) +61.8 kJ/mol  
 (D) -77.3 kJ/mol (E) -61.8 kJ/mol
21. Which of the following is true?  
 (A) As long as the disorder of the surroundings is increasing, a process will be spontaneous.  
 (B) For any process,  $\Delta S_{\text{surr}}$  and  $\Delta S_{\text{sys}}$  have opposite signs.  
 (C) If  $\Delta S_{\text{surr}} = -\Delta S_{\text{sys}}$ , the process is at equilibrium.  
 (D)  $\Delta H^\circ$  is zero for a chemical reaction at constant temperature. (E) none of these
22. For the process  $\text{benzene}_{(l)} \longrightarrow \text{benzene}_{(g)}$  at 1 atm,  $\Delta H^\circ = 30.5 \text{ kJ/mol}$  and  $\Delta S^\circ = 86.4 \text{ J/mol K}$ . Assuming these values are independent of temperature, what is the normal boiling point of benzene?  
 (A)  $0^\circ\text{C}$  (B)  $80^\circ\text{C}$  (C)  $353^\circ\text{C}$  (D)  $-80^\circ\text{C}$  (E) none of these
23. Calculate  $\Delta S$  for the heating 3.00 mole of a monatomic ideal gas from  $25^\circ\text{C}$  to  $125^\circ\text{C}$  at constant pressure.  
 (A) 3.61 J/K (B) 6.02 J/K (C) 18.0 J/K (D) 10.8 J/K (E) none of these
24. How many electrons are transferred in the following reaction:  

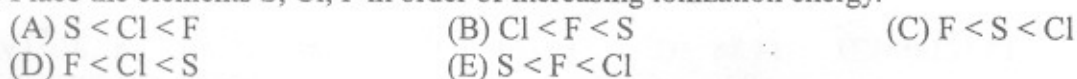
$$2\text{ClO}_3^- + 12\text{H}^+ + 10\text{I}^- \longrightarrow 5\text{I}_2 + \text{Cl}_2 + 6\text{H}_2\text{O}?$$
 (A) 12 (B) 5 (C) 2 (D) 30 (E) 10
25. A common car battery carries out the reaction:  

$$\text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4 + 2\text{H}^+ \longrightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$$
 For such a reaction  $E^\circ$  is 2.04 V. Calculate  $\Delta G^\circ$  at  $25^\circ\text{C}$ .  
 (A) -787 kJ (B) -394 kJ (C) -197 kJ (D) -98 kJ (E) -0.121 kJ
26. From the following list of observations choose the one that most clearly supports the concept "Electron in atoms have quantized energies".  
 (A) the emission spectrum of hydrogen (B) the photoelectric effect  
 (C) diffraction (D) scattering of  $\alpha$  particles by metal foil (E) cathode rays
27. Which of the following sets of quantum numbers do not represent permissible solutions of the Schrödinger equation for the electron in the hydrogen atom?  
 (A)  $n = 9 \quad l = 8 \quad m_l = -4 \quad m_s = 1/2$  (B)  $n = 8 \quad l = 2 \quad m_l = 2 \quad m_s = 1/2$   
 (C)  $n = 6 \quad l = -5 \quad m_l = -1 \quad m_s = 1/2$  (D)  $n = 6 \quad l = 5 \quad m_l = -4 \quad m_s = 1/2$   
 (E) none of these

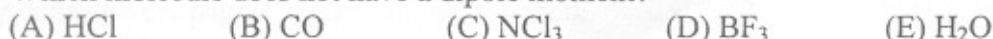
28. Which electron configuration represents the ground state? (atomic number: Ni, 28; Ga, 31; As, 33; Co, 27)



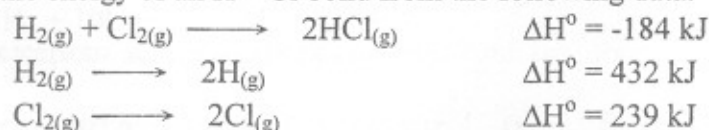
29. Place the elements S, Cl, F in order of increasing ionization energy.



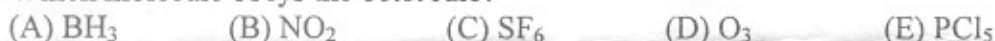
30. Which molecule does not have a dipole moment?



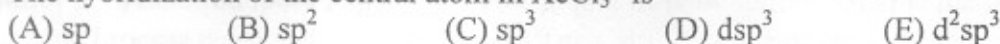
31. Calculate the energy of an H—Cl bond from the following data.



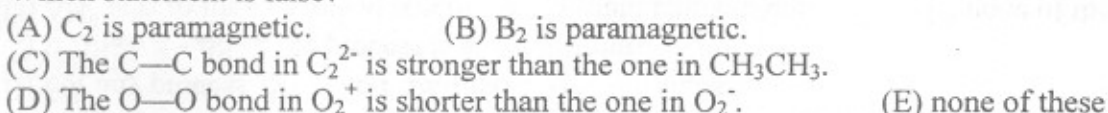
32. Which molecule obeys the octet rule?



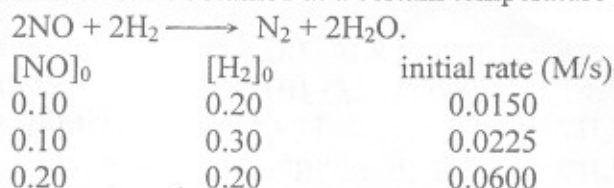
33. The hybridization of the central atom in XeCl<sub>3</sub><sup>+</sup> is



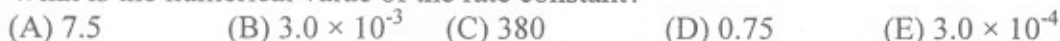
34. Which statement is false?



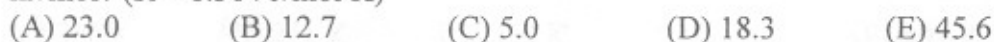
35. Initial rate data have been obtained at a certain temperature for the gaseous reaction



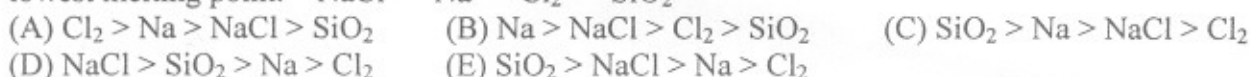
What is the numerical value of the rate constant?



36. The rate constant for a reaction increases from 10.0 s<sup>-1</sup> to 100.0 s<sup>-1</sup> when the temperature is increased from 300 K to 400 K. What is the activation energy for the reaction in kJ/mol? (R = 8.314 J/mol K)



37. By consider bonding in liquids and solids, arrange the following substance from highest to lowest melting point: NaCl Na Cl<sub>2</sub> SiO<sub>2</sub>



38. Aluminum metal crystallizes in a face-centered cubic structure. The relationship between the radius  $r$  of an Al atom and the length of an edge  $E$  of the unit cell is  
 (A)  $r = E/2$  (B)  $r = \sqrt{2}E/4$  (C)  $r = \sqrt{3}E/4$  (D)  $r = 2E$  (E)  $r = 4E$
39. The triple point of a substance is  
 (A) the point at which its solid, liquid and vapor are all in equilibrium.  
 (B) the point at which the vapor pressure of the solid is 1 atm.  
 (C) the point at which the liquid starts to condense as the temperature of vapor is lowered.  
 (D) the point at which the density of the solid and the liquid are equal.  
 (E) none of these
40. The density of a solution containing 296.6 g of  $Mg(NO_3)_2$  (formula weight: 148.33) per liter is 1.114 g/mL. The molarity of the solution is  
 (A) 2.000 M (B) 2.446 M (C) 6.001 M (D) 1.805 M (E) none of these
41. The lattice energy of NaI is 686 kJ/mol and its heat of solution is  $-7.6$  kJ/mol. The hydration energy of  $NaI_{(s)}$  is  
 (A) +15.2 kJ (B)  $-678$  kJ (C)  $-694$  kJ (D) +678 kJ (E) +694 kJ
42. Choose the correct molecular structure for  $XeF_4$  from the choices below.  
 (A) trigonal bipyramidal (B) trigonal planar (C) tetrahedral  
 (D) octahedral (E) square planar
43. The structure of the complex ion  $NiCl_4^{2-}$  is tetrahedral. The number of unpaired electrons in this complex is  
 (A) 0 (B) 1 (C) 2 (D) 3 (E) 4
44. Hemoglobin is a complex of  
 (A)  $Co^{3+}$  (B)  $Mg^{2+}$  (C)  $Fe^{3+}$  (D)  $Sc^{3+}$  (E)  $Fe^{2+}$
45. The half-life of the Cs-131 nucleus is 30 years. After 90 years, about 6 g remain. The original mass of the Cs-131 sample is closest to  
 (A) 30 g (B) 40 g (C) 50 g (D) 60 g (E) 70g
46. Which of the following is optically active (i.e. chiral)?  
 (A) dimethylamine (B) dichloromethane (C) 2-chloropropane  
 (D) 2-chlorobutane (E) 3-chloropentane
47. The boiling point of methanol is much higher than that of ethane primarily because of  
 (A) the difference in molar masses of methanol and ethane.  
 (B) the hydrogen bonding in methanol.  
 (C) the significant molecular size difference between methanol and ethane.  
 (D) the carbon-oxygen double bond in methanol. (E) none of these.
48. 
$$\left[ \text{O}-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}} \right]_n$$
- What monomer(s) is/are needed to make the polymer shown above?
- I.  $HOCH_2CH_2OH$  II.  $HOOCCH_2CH_2COOH$  III.  $HOCH_2CH_2COOH$   
 IV.  $HOCH=CHOH$  V.  $HOOCCH=CHCOOH$   
 (A) II (B) I and II (C) III (D) IV and V (E) II and III



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49. The overall shape of a protein is maintained by  
(A) hydrogen bonding (B) ionic bonds (C) dipole-dipole bonding  
(D) covalent bonds (E) all of these
50. The complementary nucleic acid sequence for the DNA sequence GAC TAC GTT AGC is  
(A) GAC TAC GTT AGC (B) TCA GCA TGG CTA (C) CGA TTG CAT CAG  
(D) CTG ATG CAA TCG (E) none of these