國立聯合大學 101 學年度
(院)學系轉學生招生考試試題紙

科目：普通化學          第 1 頁共 3 頁

選擇題分兩部份計分，1-20 題每題 2 分，21-35 題每題 4 分，共計 100 分
1. Which conditions of $P$, $T$, and $n$, respectively, are most ideal?
   A) high $P$, high $T$, high $n$  B) low $P$, low $T$, low $n$  C) high $P$, low $T$, high $n$
   D) low $P$, high $T$, high $n$  E) low $P$, high $T$, low $n$

2. Which of the following has the smallest radius?
   A) $F^-$  B) Ne  C) $O^{2-}$  D) Mg$^{2+}$  E) Na$^+$

3. Which of the following species would be expected to have the lowest ionization energy?
   A) $F^-$  B) Ne  C) $O^{2-}$  D) Mg$^{2+}$  E) Na$^+$

4. Which of the following ionic compounds has the smallest lattice energy (i.e., the lattice energy least favorable to a stable lattice)?
   A) LiF  B) CsI  C) NaCl  D) BaO  E) MgO

5. In general, as you go cross a period in the periodic table from left to right:
   (1) the atomic radius _______  (2) the electron affinity becomes _______  (3) the first ionization energy _______.
   A) decreases, decreasingly, increases  B) increases, increasingly, decreases  C) increases, increasingly, increases
   D) decreases, increasingly, increases  E) decreases, increasingly, decreases

6. You have two salts, AgX and AgY, with very similar $K_{sp}$ values. You know that $K_{sp}$ for HX is much greater than $K_{sp}$ for HY. Which salt is more soluble in acidic solution?
   A) AgX  B) AgY  C) They are equally soluble in acidic solution  D) Cannot be determined by the information given.
   E) None of these

7. For the following reaction at equilibrium, which one of the changes below would cause the equilibrium to shift to the left?
   \[ 2\text{NOBr}(g) \rightleftharpoons 2\text{NO}(g) + \text{Br}_2(g), \quad \Delta H_{\text{rxn}} = 30 \text{ kJ/mol} \]
   A) Increase the container volume.  B) Remove some NO.  C) Remove some Br$_2$.
   D) Add more NOBr.  E) Decrease the temperature.

8. If the solid ammonium fluoride (NH$_4$F) is dissolved in pure water, will the resulting solution be acidic, basic, or neutral?  Note: For NH$_3$, $K_b = 1.8 \times 10^{-5}$; for HF, $K_a = 7.2 \times 10^{-4}$.
   A) Acidic  B) Basic  C) Neutral  D) None of these is correct  E) There is no way to tell.

9. For a certain reaction, the standard free energy change is -40.0 kJ at 300 K and -60.0 kJ at 600 K. For this reaction
   A) $\Delta H$ is positive, and $\Delta S$ is positive.  B) $\Delta H$ is positive, and $\Delta S$ is negative.
   C) $\Delta H$ is negative, and $\Delta S$ is positive.  D) $\Delta H$ is negative, and $\Delta S$ is negative.  E) impossible to tell.

10. For the reaction $X + Y \rightarrow Z$, the reaction rate is found to depend only upon the concentration of $Z$. A plot of 1/X versus time gives a straight line. What is the rate law for this reaction?
    A) rate = $k [X]^0$  B) rate = $k [X]^1$  C) rate = $k [X]^2$  D) rate = $k [X][Y]$  E) rate = $[X]^2[Y]$.

11. The normal boiling point of liquid X is less than that of Y, which is less than that of Z. Which of the following is the correct order of boiling point of the three liquids at STP?

12. For which gas do the molecules have the smallest average kinetic energy at 25°C?
    A) He  B) F$_2$  C) Cl$_2$  D) N$_2$  E) all gases the same

13. Predict the signs of $\Delta S$, $\Delta H$, and $\Delta G$ for the following reaction at 25°C:
    \[ \text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}(l) \]
    A) $\Delta S^0$, $\Delta H^0$, $\Delta G^0$  B) $\Delta S^0$, $\Delta H^0$, $\Delta G^0$
    C) $\Delta S^0$, $\Delta H^0$, $\Delta G^0$  D) $\Delta S^0$, $\Delta H^0$, $\Delta G^0$
    E) $\Delta S^0$, $\Delta H^0$, $\Delta G^0$

14. Consider the following reaction at equilibrium at a total pressure $P_1$, 2SO$_2$(g) + O$_2$(g) $\rightleftharpoons$ 2SO$_3$(g). Suppose the volume of this system is compressed to one-half its initial volume and the total equilibrium is reestablished. The new equilibrium total pressure will be
    A) twice of $P_1$  B) more than twice of $P_1$  C) half of $P_1$  D) less than twice of $P_1$
    E) unchanged.
    Select the correct molecular shape for the given species from the choices below(15–16題):
    15. IF$_5$:  A) square planar  B) tetrahedral  C) pyramidal  D) octahedral  E) none of these
    16. SF$_4$:  A) linear  B) trigonal planar  C) tetrahedral  D) bent  E) none of these
17. For a reaction in a voltaic cell, both $\Delta H^\circ$ and $\Delta S^\circ$ are positive. Which of the following statements is true?
   A) $E_{\text{cell}}^\circ$ will increase with an increase in temperature.
   B) $E_{\text{cell}}^\circ$ will decrease with an increase in temperature.
   C) $E_{\text{cell}}^\circ$ will not change when the temperature increases.
   D) $G^\circ > 0$ for all temperatures.
   E) None of the above statements is true.

18. In the titration of a weak acid HA with 0.100 M NaOH, the stoichiometric point is known to occur at a pH value of approximately 11. Which of the following indicators would be best to use to mark the endpoint of this titration?
   A) an indicator with $K_a = 10^{-10}$
   B) an indicator with $K_a = 10^{-3}$
   C) an indicator with $K_a = 10^{-14}$
   D) an indicator with $K_a = 10^{-11}$
   E) an indicator with $K_a = 10^{-12}$

19. Consider the gaseous reaction $\text{CO}(g) + \text{Cl}_2(g) \rightleftharpoons \text{COCl}_2(g)$. What is the expression for $K_p$ in terms of $K$?
   A) $K(RT)$
   B) $K/(RT)$
   C) $K(RT)^2$
   D) $K/(RT)^2$
   E) $1/K(RT)$

20. The density of the solid phase of a substance is 0.90 g/cm³ and the density of the liquid phase is 1.0 g/cm³. A large increase in pressure will
   A) lower the freezing point
   B) raise the freezing point
   C) lower the boiling point
   D) raise the triple point
   E) lower the triple point

21. Consider the reaction: $\text{A}_2 + \text{B}_2 \rightarrow 2 \text{AB}$ $\Delta H = -321 \text{ kJ}$ The bond energy for $\text{A}_2$ is half the amount of $\text{AB}$. The bond energy of $\text{B}_2$ is 393 kJ/mol. What is the bond energy of $\text{A}_2$?
   A) 714 kJ/mol
   B) 554 kJ/mol
   C) 238 kJ/mol
   D) -161 kJ/mol
   E) none of these

22. At a given temperature, you have a mixture of benzene (vapor pressure of pure benzene = 745 torr) and toluene (vapor pressure of pure toluene = 290 torr). The mole fraction of toluene in the solution is 0.590. Assuming ideal behavior, calculate the mole fraction of benzene in the vapor above the solution.
   A) 0.213
   B) 0.778
   C) 0.641
   D) 0.359
   E) 0.590

23. The vapor pressure of water at 25.0°C is 23.8 torr. Determine the mass of glucose (molar mass = 180 g/mol) needed to add to 500.0 g of water to change the vapor pressure to 22.97 torr.
   A) 10.7 g
   B) 107 g
   C) 90.0 g
   D) 6.35 g
   E) 184 g

24. A 25.0 g sample of garden compost was analyzed for chloride content. The sample was dissolved in water and the chloride was precipitated as silver chloride. 1.58 g of dried precipitate was obtained. Calculate the percent chloride in the sample.
   A) 6.3%
   B) 1.37%
   C) 62%
   D) 2.4%
   E) 1.56%

25. Calculate the molarity of a concentrated hydrochloric acid solution that is 36.52% HCl by mass and has a density of 1.20 g/mL.
   A) 6.01
   B) 21.9
   C) 15.2
   D) 12.0
   E) 4.17

26. For a certain reaction, $\Delta H^\circ = -77.6 \text{ kJ}$ and $\Delta S^\circ = -137.6 \text{ J/K}$. If $n = 2$, calculate $E^\circ$ for the reaction at 25°C.
   A) 0.0447 V
   B) 0.491 V
   C) 0.287 V
   D) 0.134 V
   E) 0.249 V

27. For the reaction $\text{SO}_2(g) + \text{NO}_2(g) \rightleftharpoons \text{SO}_3(g) + \text{NO}(g)$, the equilibrium constant is 18.0 at 1000°C. If 1.0 mole of $\text{SO}_2$ and 2.0 moles of $\text{NO}_2$ are placed in a 20.0 L container, what concentration of $\text{SO}_3$ will be present at equilibrium?
   A) 0.11 mol/L
   B) 0.25 mol/L
   C) 0.48 mol/L
   D) 2.22 mol/L
   E) 1.18 mol/L

28. The $K_f$ for the complex ion $\text{Ag(NH}_3)_2^+$ is $1.7 \times 10^7$. The $K_{sp}$ for AgCl is $1.6 \times 10^{-10}$. Calculate the molar solubility of AgCl in 1.0 M NH$_3$.
   A) $5.2 \times 10^{-2}$
   B) $4.7 \times 10^{-2}$
   C) $2.9 \times 10^{-3}$
   D) $1.3 \times 10^{-5}$
   E) $1.7 \times 10^{-10}$

29. A student weighs out 0.681 g of KHP (molar mass = 204.22 g/mol) and titrates to the equivalence point with 36.78 mL of a 0.1 M NaOH solution. What is the concentration of the stock NaOH solution? KHP is an acid with one acidic proton.
   A) 0.00333 M
   B) 0.123 M
   C) 0.0185 M
   D) 0.0907 M
   E) none of these

30. You have 30.4 g of O$_2$ gas in a container with twice the volume as one with CO$_2$ gas. The pressure and temperature of both containers are the same. Calculate the mass of carbon dioxide gas you have in the container.
   A) 41.8 g
   B) 15.45 g
   C) 20.91 g
   D) 16.90 g
   E) none of these

31. Nitrogen gas (N$_2$) reacts with hydrogen gas (H$_2$) to form ammonia (NH$_3$). At 200°C in a closed container, 1.0 atm of nitrogen gas is mixed with 2.0 atm of hydrogen gas. At equilibrium, the total pressure is 2.3 atm. Calculate the partial pressure of hydrogen gas at equilibrium.
   A) 2.3 atm
   B) 0.95 atm
   C) 1.3 atm
   D) 0.0 atm
   E) none of these

32. What is the molar solubility of Fe(OH)$_2$ in a buffer of pH 10.0? Fe(OH)$_2$ → Fe$^{2+}$ + 2 OH$^-$. $K_{sp} = 8.0 \times 10^{-16}$
   A) 8.0 $\times 10^{-16}$ M
   B) 8.0 $\times 10^{-12}$ M
   C) 8.0 $\times 10^{-10}$ M
   D) 8.0 $\times 10^{-8}$ M
   E) 2.0 $\times 10^{-8}$ M

33. Calculate the pH of a buffer solution containing 0.25 moles sodium acetate and 0.30 moles acetic acid (HOAc) to which 0.20 moles HCl are added. $pK_a$ (HOAc) = 4.74.
   A) 5.47
   B) 4.74
   C) 4.47
   D) 4.23
   E) 3.74
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