國立中正大學
114 學年度碩士班招生考試
試 題

[第 2 節]

科目名稱	一般化學
系所組別	化學暨生物化學系

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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選擇題，共 25 題，每題 4 分，共 100 分，答錯不倒扣。

1. Select the compound in which chlorine has its lowest possible oxidation number.
(A) $NaClO_4$ (B) $HClO_3$ (C) $NaClO_2$ (D) HClO (E) Cl_2O_7

2. Which of the following species have the same geometries?
(A) SF_4 and XeF_4 (B) BeH_2 and C_2H_2 (C) PCl_3 and SO_3 (D) CO_2 and SO_2 (E) CO_2 and H_2O

3. The vapor pressure of methanol (CH_3OH) and ethanol (C_2H_5OH) at 20 °C are 94 mmHg and 44 mmHg. A solution is prepared by mixing 30 g methanol and 45 g ethanol. What is the vapor pressure (in mmHg) of ethanol above this solution?
(A) 22 (B) 41 (C) 46 (D) 56 (E) 74

4. How many liters of antifreeze (ethylene glycol, $CH_2(OH)CH_2(OH)$) would you add to a car radiator containing 6.50 L of water if the coldest winter temperature in your area at –20.0 °C? (The density of ethylene glycol is 1.11 g/cm^3)
(A) 0.92 L (B) 1.23 L (C) 1.86 L (D) 2.46 L (E) 3.93 L

5. A 73.5-mL sample of 0.18 *M* HNO_2 ($K_a = 4.0 \times 10^{-4}$) is titrated with 0.12 *M* NaOH. What is the pH after 25.2 mL of NaOH has been added?
(A) 10.07 (B) 7.00 (C) 3.93 (D) 2.76 (E) 2.87

6. A mixture of NaCl and sucrose ($C_{12}H_{22}O_{11}$) of combined mass 10.2 g is dissolved in enough water to make up a 250 mL solution. The osmotic pressure of the solution is 7.32 atm at 23 ºC. Calculate the percent by mass of NaCl in the mixture.
(A) 7.1% (B) 14.2% (C) 21.3% (D) 78.7% (E) 85.8%

7. An electron in the hydrogen atom makes a transition from an energy state of principal quantum numbers n = ni to the n =3 state. If the photon emitted has a wavelength of 1280 nm, what is the value of ni? ($R_H = 1.097 \times 10^7$ m^{-1})
(A) 2 (B) 4 (C) 5 (D) 6 (E) 7

8. Which of the following statements is true?

I. Catalysts are an effective means of changing the position of an equilibrium.

II. An endothermic reaction shifts toward reactants when heat is added to the reaction.

III. The concentration of the products equals that of the reactants and is constant at equilibrium.

IV. When two opposing processes are proceeding at identical rates, the system is at equilibrium.

V. None of the above statements is true.

(A) I (B) II (C) III (D) IV (E) V

9. Which charge(s) of O_2 would give a bond order of 2.5?

(A) +2 (B) +3 (C) +1 (D) −1 (E) −2

10. For the following reaction: $Mg(s) + 2AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2Ag(s)$, which species is oxidizing agent?

(A) Mg (B) $AgNO_3$ (C) Ag (D) This is not a redox reaction (E) $Mg(NO_3)_2$

11. Which of the following molecules are nonpolar species?

(A) xenon difluoride (B) amminia (C) bromine pentafluoride (D) tellurium tetrachloride (E) phosphorus trichloride

12. When the concentration of A in the reaction A → B was changed from 0.6 M to 1.20 M, the half-life increases from 2.0 min to 4.0 min at 25 ºC. Calculate the order of the reaction.

(A) 2 (B) 3 (C) 1 (D) 4 (E) 0

13. The reaction A→2B is first order in A with a rate constant of $2.8 \times 10^{-2}\ s^{-1}$ at 80 ^{0}C. How long will it take for A to decrease from 0.88 *M* to 0.14 *M* ?

(A) 22s (B) 33s (C) 44s (D) 55s (E) 66 s

14. A mixture of hydrogen and chlorine remains unreacted until it is exposed to ultraviolet light from a burning magnesium strip. Then the following reaction occurs very rapidly.

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ $\Delta G = -45.54$ kJ

$\Delta H = -44.12$ kJ

$\Delta S = -4.76$ J/K

Select the statement below that best explains this behavior

I. The reactants are thermodynamically more stable than the products .

II. The reaction is spontaneous, but the reactants are kinetically stable.

III. The reaction has a small equilibrium constant.

IV. The ultraviolet light raises the temperature of the system and makes the reaction more favorable.

V. The negative value for ΔS slows down the reaction.

(A) I (B) II (C) III (D) IV (E) V

15. Which of the followings is $K_c = K_p$?

(A) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

(B) $H_{2(g)} + I_{2(s)} \rightleftharpoons 2HI_{(g)}$

(C) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

(D) $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$

(E) $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$

16. The equilibrium concentrations for the reaction between carbon monoxide and molecular chlorine to form $COCl_2$ (g) at 74 ^{0}C are [CO] = 0.012 M, [Cl_2] = 0.054 M, and [$COCl_2$] = 0.14 M. Calculate the equilibrium constants K_p.

(A) 4.4 (B) 5.5 (C) 66 (D) 7.7 (E) 220

17. At a particular temperature, N_2O_5 decomposes according to a first-order rate law with a half-life of 3.0 s. If the initial concentration of N_2O_5 is 1.0×10^{16} molecules/cm^3, what will be the concentration in molecules/cm^3 after 10.0 s ?

I. 6.3×10^3

II. 1.8×10^{12}

III. 9.4×10^2

IV. 7.3×10^9

V. 9.9×10^{14}

(A) I (B) II (C) III (D) IV (E) V

18. What is the solubility of silver chloride in g/L ? (Ksp = 1.6×10^{-10}，The atomic mass of Ag is 107.87 g/mol and Cl is 35.45 g/mol)

(A) 1.8×10^{-3} g/L

(B) 18×10^{-3} g/L

(C) 0.18×10^{-3} g/L

(D) 18 g/L

(E) 1.8 g/L

19. The reaction NH3(g) + HCl(g) → NH4Cl(s) is spontaneous at 25 ^{0}C. The signs of △G and △S are __.

(A) △G > 0, △S < 0 (B) △G < 0, △S < 0 (C) △G > 0, △S > 0 (D) △G > 0, △S > 0

(E) △G = 0, △S = 0

20. The reaction below having a positive entropy change is ____.

(A) $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$

(B) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

(C) $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

(D) $U_{(s)} + 3F_{2(g)} \rightarrow UF_{6(s)}$

(E) $H_2O_{(l)} \rightarrow H_2O_{(s)}$

21. Which of the following statements is true of second ionization energies?

I. That of Al is higher than that of Mg because the electrons are taken from the same energy level, but the Al atom has one more proton.

II. That of Al is higher than that of Mg because Mg wants to lose the second electron, so it is easier to take the second electron away.

III. That of Al is lower than that of Mg because the second electron taken from Al is in a p orbital, so it is easier to take away.

IV. That of Al is lower than that of Mg because Mg wants to lose the second electron, so the energy change is greater.

V. The second ionization energies are equal for Al and Mg.

(A) I (B) II (C) III (D) IV (E) V

22. One isotope of an element has mass number 27 and 14 neutrons in the nucleus. The cation derived from the isotope has 10 electrons. What is the symbol for this cation?

(A) Al^{3+} (B) Br^- (C) Ca^{2+} (D) Mg^{2+} (E) Zn^{2+}

23. Which of the following is diamagnetic?

(A) N_2　(B) C_2^+　(C) H_2^+　(D) N_2^+　(E) F_2^+

24. Which of the following reactions will have the largest equilibrium constant at 298 K?

(A) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$　$\Delta G° = +131.1$ kJ

(B) $2Hg(g) + O_2(g) \rightarrow 2HgO(s)$　$\Delta G° = -180.8$ kJ

(C) $3O_2(g) \rightarrow 2O_3(g)$　$\Delta G° = +326$ kJ

(D) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$　$\Delta G° = -28.0$ kJ

(E) It is not possible to determine without more information.

25. Which of the following statements is true?

I. Catalysts are an effective means of changing the position of an equilibrium.

II. An endothermic reaction shifts toward reactants when heat is added to the reaction.

III. The concentration of the products equals that of the reactants and is constant at equilibrium.

IV. When two opposing processes are proceeding at identical rates, the system is at equilibrium.

V. None of the above statements is true.

(A) I　(B) II　(C) III　(D) IV　(E) V