

100 學年度四年制二、三年級轉學生招生考試

四技二年級 化學工程與生物科技系、分子科學與工程系

第三節 專業科目(二) 普通化學 試題

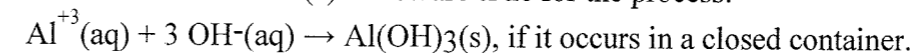
第一頁 共三頁

注意事項：

1. 本試題共 40 題，配分共 100 分，每題 2.5 分。
2. 各試題為單選題，請依題號順序作答，不必抄題。
3. 計算題之答案選項，請以最接近者作為答案。
4. 全部答案均須寫在答案卷之答案欄內作答，否則不予計分。

1. In a zinc-lead cell the reaction is: $\text{Pb}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Pb}(\text{s}) + \text{Zn}^{2+}(\text{aq})$, $E^\circ = 0.637 \text{ V}$
Which of the following statements about this cell is **FALSE**?
(A) The zinc electrode is the cathode.
(B) The reaction will go in the direction indicated.
(C) The shorthand notation is $\text{Zn}(\text{s}) | \text{Zn}^{2+}(\text{aq}) || \text{Pb}^{2+}(\text{aq}) | \text{Pb}(\text{s})$
(D) The actual cell voltage is less than +0.637 volts because of concentration polarization and possible other factors.
(E) The lead electrode is positively charged.
2. Determine E°_{cell} for the reaction: $2 \text{Al} + 3 \text{Zn}^{2+} \rightarrow 2 \text{Al}^{3+} + 3 \text{Zn}$. The half reactions are:
 $\text{Al}^{3+}(\text{aq}) + 3 \text{e}^- \rightarrow \text{Al}(\text{s})$ $E^\circ = -1.676 \text{ V}$; $\text{Zn}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Zn}(\text{s})$ $E^\circ = -0.763 \text{ V}$
(A) 0.913 V (B) -2.439 V (C) 2.439 V (D) -1.063 V (E) -0.913 V
3. For $\text{Cl}_2\text{O}(\text{g}) + 3/2 \text{O}_2(\text{g}) \rightarrow 2 \text{ClO}_2$ $\Delta H^\circ = 126 \text{ kJ/mol}$, and $\Delta S^\circ = -74.9 \text{ J/(mol}\cdot\text{deg)}$ at 377°C .
What is K_{eq} ?
(A) 0.97 (B) 6.12×10^{-7} (C) 4.27×10^{-22} (D) 9.17×10^{-15} (E) 1.07×10^{14}
4. If the vapor pressure of water in an open system at 25°C is 23.8 mmHg, what is ΔG for the reaction below at 25°C ? $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g}, 23.8 \text{ mmHg})$
(A) 0 kJ/mol (B) -8.58 kJ/mol (C) +8.58 kJ/mol (D) -0.720 kJ/mol
5. Consider the reaction of 25.0 mL of 0.20 M $\text{AgNO}_3(\text{aq})$ with 25.0 mL of 0.20 M $\text{NaBr}(\text{aq})$ to form $\text{AgBr}(\text{s})$ at 25°C . What is ΔG for this reaction? The K_{sp} of AgBr is 5.0×10^{-13} at 25°C .
(A) -58.8 kJ/mol (B) -70.2 kJ/mol (C) +58.8 kJ/mol (D) +70.2 kJ/mol
6. Consider the reaction: $\text{H}_2\text{X}(\text{g}) \rightarrow \text{HX}(\text{g}) + \text{X}(\text{g})$
 $\Delta H^\circ_{\text{rxn}} = 18.4 \text{ kJ/mol}$, $\Delta S^\circ_{\text{rxn}} = 23.1 \text{ J/mol}\cdot\text{K}$. What is K_{eq} for this reaction at 525 K?
(A) 0.387 (B) 0.993 (C) 0.238 (D) 4.23 (E) 1.01

7. Indicate the statement(s) which are **true** for the process:



- (I) ΔS increases because the final molecule is more complicated.
 - (II) Entropy decreases because the product is in the solid phase.
 - (III) The two ions achieve a high degree of order as they crystalize, therefore ΔS is positive.
 - (IV) Entropy of the system is unchanged because the system is sealed and at a constant temperature.
- (A) (I) and (II)
(B) (I) and (III)
(C) (II) only
(D) (I), (II), (IV)
(E) (I) and (IV)
8. What is the final temperature in the bomb calorimeter if 1.785 grams of benzoic acid ($\text{HC}_7\text{H}_5\text{O}_2$) is combusted in a calorimeter with a heat capacity of $5.02 \text{ kJ/}^\circ\text{C}$ and initial temperature of 24.62°C ? The heat of combustion of benzoic acid is -26.42 kJ/g .
(atomic mass: C = 12.0107, H = 1.0079, O = 15.9994)
(A) 51.0°C (B) 29.8°C (C) 31.2°C (D) 15.5°C (E) 33.7°C
 9. Enthalpy is defined as:
(A) the heat of combustion
(B) the energy contained within a system
(C) the sum of the internal energy and the pressure-volume product of a system
(D) the sum of the kinetic and potential energies
(E) the work not limited to pressure volume work
 10. Calculate the enthalpy change for the following reaction at 25°C . The value of ΔH°_f in kJ/mol is given below each species:
 $2 \text{Fe}_2\text{O}_3(\text{s}) + 6 \text{CO}(\text{g}) \rightarrow 4 \text{Fe}(\text{s}) + 6 \text{CO}_2(\text{g})$
-824.2 -110.5 0 -393.5
(A) -49.6 kJ (B) 541 kJ (C) -1380 kJ (D) -3350 kJ (E) -24.8 kJ
 11. Find statements describing the trends in the chemical behavior of the **elements**:
(I) The atomic size within a period of the periodic table decreases from left to right.
(II) Metallic character increases within a period from right to left.
(III) Basic oxides are formed by the elements near the end of each period.
(IV) The tendency to lose electrons is greater among the elements of Group 1 than in Group 13.
(V) Ionization potential increases as atomic size decreases.
(A) (I), (II), (III), (IV)
(B) (II), (III), (IV), (V)
(C) (I), (II), (IV), (V)
(D) (I), (II), (III), (V)
(E) (I), (III), (IV), (V)

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12. Choose the paramagnetic atom or ion: Ca, Ne, Sc^{3+} , Cl^- , Na.
 (A) Ca (B) Ne (C) Sc^{3+} (D) Cl^- (E) Na
13. When 100 mL each of 2.0×10^{-4} M Ca^{2+} and 2.0×10^{-2} M F^- are mixed, what is the remaining Ca^{2+} ion concentration and is precipitation complete? The solubility product constant of CaF_2 is 5.3×10^{-9} .
 (A) 5.6×10^{-4} , no (B) 1.7×10^{-8} , yes (C) 4.3×10^{-7} , no
 (D) 1.7×10^{-6} , yes (E) 5.4×10^{-5} , no
14. Choose the **INCORRECT** statement.
 (A) Bonds between like atoms are nonpolar bonds.
 (B) Polar bonds are caused by the bonding pair of electrons being attracted more to one atom than the other.
 (C) Electronegativity is the ability of an atom to attract electrons when involved in a bond.
 (D) A difference in electronegativity between two atoms causes a polar bond.
 (E) If the ΔEN value is large the bond is polar covalent.
15. Which compound would be expected to have the **shortest** carbon-carbon bond?
 (A) H_3CCH_3 (B) HCCH (C) H_2CCH_2 (D) F_3CCF_3 (E) Cl_2CCCl_2
16. What is the correct molecular geometry for SeBr_3^{+} ?
 (A) trigonal pyramidal (B) tetrahedral (C) trigonal planar (D) bent (E) T-shaped
17. What is the pH of a 1.0 M solution of Na_2SO_3 ? $K_{a1} = 1.3 \times 10^{-2}$, $K_{a2} = 6.2 \times 10^{-8}$?
 (A) 6.8 (B) 7.2 (C) 7.0 (D) 10.4 (E) 3.6
18. What is the wavelength of the line in the Balmer series of hydrogen corresponding to the transition from $n = 5$ to $n = 2$? The constant for Balmer's equation is $3.2881 \times 10^{15} \text{ s}^{-1}$.
 (A) 304 nm (B) 30.4 nm (C) 329 nm (D) 535 nm (E) 434 nm
19. The quantum numbers of the last electron of nickel could be:
 (A) $n = 3, \ell = 2, m_\ell = 0, m_s = 1/2$
 (B) $n = 4, \ell = 2, m_\ell = 0, m_s = 1/2$
 (C) $n = 3, \ell = 1, m_\ell = 0, m_s = 1/2$
 (D) $n = 3, \ell = 2, m_\ell = 0, m_s = 0$
 (E) $n = 3, \ell = 2, m_\ell = 1/2, m_s = 1/2$
20. A certain acid, HA, has a K_a given by: $\text{HA} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{A}^-$ $K_a = 6.80 \times 10^{-6}$
 What is the pH of a 0.247 M solution of the acid's potassium salt, KA, which undergoes the hydrolysis reaction? $\text{A}^- + \text{H}_2\text{O} \rightleftharpoons \text{OH}^- + \text{HA}$
 (A) 4.72 (B) 9.28 (C) 4.11 (D) 9.89 (E) 9.44
21. Predict the following compound whether the solution is acidic, basic or neutral and why:
 (A) acidic because Na_2CO_3 is a strong acid
 (B) basic because Na_2CO_3 is a weak base
 (C) neutral because there is no hydrolysis
 (D) basic because Na_2CO_3 is the salt of a weak acid
 (E) acidic because Na_2CO_3 is the salt of a weak base
22. Which of the following solutions has the highest fluoride concentration?
 (atomic mass: F = 18.9984)
 (A) 0.05 M CaF_2
 (B) 2.1 mg NaF/L
 (C) a solution having 1.5 mg F^- /L
 (D) a solution having 0.06 M F^-
 (E) 0.05 M NaF
23. A disproportionation reaction is one in which:
 (A) the equation is not balanced
 (B) the same substance is oxidized and reduced
 (C) more of one substance reacts than another
 (D) water must be added
 (E) both reactants are reduced
24. Iron in the form FeCl_2 can be determined by titration with potassium dichromate:
 $6\text{FeCl}_2(\text{aq}) + \text{K}_2\text{Cr}_2\text{O}_7(\text{aq}) + 14\text{HCl}(\text{aq}) \rightarrow 6\text{FeCl}_3(\text{aq}) + 2\text{CrCl}_3(\text{aq}) + 2\text{KCl}(\text{aq}) + 7\text{H}_2\text{O}(\text{l})$
 An iron sample of mass 0.800 g required 18.80 mL of 0.0120 M $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ to reach the end point. How many moles of FeCl_2 were in the sample? (atomic mass: Fe = 55.845, Cl = 35.453)
 (A) 1.43×10^{-2} mol
 (B) 1.35×10^{-3} mol
 (C) 3.75×10^{-5} mol
 (D) 2.26×10^{-4} mol
 (E) 1.13×10^{-4} mol
25. What is the correct name for the following organic structure?
 $\text{CH}_3\text{CH}_2\text{CHBrCH}_2\text{CH}_3$
 (A) 3-bromopentane
 (B) 3-bromopropane
 (C) 1-bromo-1-ethylpropane
 (D) pentane
 (E) pentylbromide
26. Which of the following is the **correct** definition of an isomer?
 (A) Isomers are molecules that have the same empirical formula but different arrangements of atoms in space.
 (B) Isomers are molecules that have the same molecular formula but different arrangements of atoms in space.
 (C) Isomers are molecules that have the same arrangements of atoms in space but different empirical and molecular formulas.
 (D) Isomers are molecules that have the same molecular formula but contain different isotopes.
 (E) Isomers are molecules with the same empirical formula but have different isotopes.

27. Consider the following equation: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$ $K_c = 5.8 \times 10^{-3}$
 If the initial concentration of $\text{N}_2\text{O}_4(\text{g}) = 0.040 \text{ M}$ and the initial concentration of $\text{NO}_2(\text{g})$ is 0 M , what is the equilibrium concentration of $\text{N}_2\text{O}_4(\text{g})$?
 (A) $1.7 \times 10^{-2} \text{ M}$ (B) $1.9 \times 10^{-2} \text{ M}$ (C) $3.3 \times 10^{-2} \text{ M}$ (D) $2.6 \times 10^{-2} \text{ M}$ (E) $2.3 \times 10^{-6} \text{ M}$
28. For the reaction $2 \text{A}(\text{g}) \rightleftharpoons \text{B}(\text{g}) + \text{C}(\text{g})$, $K_c = 1.25$ at 300 K . If a 1.00 L mixture contains 0.619 mol A , 0.693 mol B , and 0.689 mol C at 300 K , will the mixture be in equilibrium? If not, in what direction will a net reaction occur?
 (A) Yes, at equilibrium.
 (B) No, net reaction to the left.
 (C) No, net reaction to the right.
 (D) No, but there is no net reaction.
 (E) Yes, net reaction to the right
29. Choose the **INCORRECT** statement.
 (A) Since colloidal particles are large aggregates of atoms they are electrically neutral.
 (B) Colloidal suspensions can be prepared in which the particles do not settle.
 (C) The addition of electrolytes to a colloidal suspension will sometimes cause the particles to coalesce and precipitate.
 (D) Colloidal particles reflect light from a beam.
 (E) Colloidal suspensions exhibit the Tyndall Effect.
30. Solutions are made that contain 0.10 moles of each of the following compounds in 100 g of H_2O . Choose the compound whose solution will have the highest freezing point.
 (A) K_2SO_4 (B) NaI (C) $\text{Mg}(\text{CH}_3\text{CO}_2)_2$ (D) $\text{Ca}_3(\text{PO}_4)_2$ (E) $\text{Sr}(\text{NO}_3)_2$
31. Calculate the volume of $\text{H}_2(\text{g})$ expressed at STP, required to react with 3.00 L of $\text{CO}(\text{g})$ at STP in the following reaction:
 $3 \text{CO}(\text{g}) + 7 \text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{g}) + 3 \text{H}_2\text{O}(\text{l})$
 (A) 3.00 L (B) 7.00 L (C) 10.0 L (D) 22.4 L (E) 1.00 L
32. Phosphine gas oxidizes spontaneously on exposure to air, as represented by:
 $2 \text{PH}_3(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow \text{P}_2\text{O}_3(\text{s}) + 3 \text{H}_2\text{O}(\text{g})$
 What volume of oxygen gas, at 720 torr and 37°C , would be consumed in the formation of 22.0 g of P_2O_3 by this process? (atomic mass: $\text{P} = 30.9738$, $\text{O} = 15.9994$)
 (A) 16.1 L (B) 12.5 L (C) 11.2 L (D) 8.05 L (E) 1.92 L
33. The first order reaction $\text{A} \rightarrow \text{products}$ has $t_{1/2} = 150 \text{ sec}$. What percent of the sample remains unreacted after 300 sec ?
 (A) 25% (B) 50% (C) 12.5% (D) 0.0% (E) 100%
34. The first-order reaction $\text{A} \rightarrow \text{Products}$ has a half-life, $t_{1/2}$, of 55.0 min at 25°C and 6.8 min at 100°C . What is the activation energy for this reaction?
 (A) -25.8 kJ/mol (B) -38.8 kJ/mol (C) 347 kJ/mol (D) 25.8 kJ/mol (E) 38.8 kJ/mol

35. Chromium in its **+VI** oxidation state is considered a hazardous, carcinogenic species, destruction of which may be accomplished by the process symbolized as:
 $4 \text{Zn} + \text{K}_2\text{Cr}_2\text{O}_7 + 7 \text{H}_2\text{SO}_4 \rightarrow 4 \text{ZnSO}_4 + 2 \text{CrSO}_4 + \text{K}_2\text{SO}_4 + 7 \text{H}_2\text{O}$
 If 1.0 mol of each reactant is mixed, what is the limiting reagent, and what is the theoretical yield of chromium(II) sulfate?
 (A) Zn , 0.50 mol
 (B) $\text{K}_2\text{Cr}_2\text{O}_7$, 2.0 mol
 (C) H_2SO_4 , 0.29 mol
 (D) H_2 , 1.0 mol
 (E) no limiting reagent, 1.0 mol
36. Silver possesses two stable isotopes: ^{107}Ag (106.90 u) and ^{109}Ag (108.90 u). If the average atomic mass of Ag is **107.87 u**, what is the percent abundance of ^{107}Ag ?
 (A) 48.5% (B) 50.0% (C) 51.5% (D) 46.3% (E) 53.8%
37. An extensive property is
 (A) dependent on the quantity of matter observed
 (B) difficult to measure
 (C) independent of the quantity of matter observed
 (D) is a unique value regardless of the measurement conditions
 (E) always strongly dependent on the external conditions
38. A substance has a heat of fusion of 61.5 kJ/mol and a heat of deposition of -167.4 kJ/mol . What is the heat of sublimation in kJ/mol ?
 (A) $(-61.5) \text{ kJ/mol}$
 (B) $(61.5 - 167.4) \text{ kJ/mol}$
 (C) $(61.5 + 167.4) \text{ kJ/mol}$
 (D) $(167.4 - 61.5) \text{ kJ/mol}$
 (E) $(167.4) \text{ kJ/mol}$
39. Given the data below, determine the molar enthalpy change of vaporization of COCl_2 .
 COCl_2 , $P_1 = 40 \text{ mmHg}$, $t_1 = -50.3^\circ\text{C}$, $P_2 = 100 \text{ mmHg}$, $t_2 = -35.6^\circ\text{C}$
 (A) 0.518 kJ/mol (B) 27.4 kJ/mol (C) 4.32 kJ/mol (D) 0.928 kJ/mol (E) 0.112 kJ/mol
40. The inclusion of a small amount of phosphorus in a crystal of pure germanium yields what kind of semiconductor?
 (A) an insulator
 (B) an amorphous solid
 (C) *n*-type, in which extra electrons carry the current
 (D) *p*-type, in which a deficiency of electrons carries the current
 (E) *p-n-p* type

