國立成功大學 103 學年度轉學生招生考試試題

系所組別：化學系

考試科目：普通化學

考試日期：0713，節次：3

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、單選題: (60%，每題 3 分) (atomic mass: C: 12; O:16; H:1; Cl:35.5)

1. Which of the following is ***not*** the correct chemical formula for the compound named?
(A) Li_2O lithium oxide (B) Mg_3N_2 magnesium nitride (C) HClO hypochlorous acid
(D) $BaPO_4$ barium phosphate (E) $Zn(NO_3)_2$ zinc nitrate

2. Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula?
(A) $C_3H_5O_2$ (B) $C_3H_3O_4$ (C) C_2HO_3 (D) $C_2H_5O_4$ (E) C_3HO_3

3. When the equation $xNH_3 + yO_2 \rightarrow zNO + wH_2O$ is balanced with the smallest set of integers, the sum of the coefficients (x+y+z+w) is
(A) 15 (B) 17 (C) 19 (D) 21 (E) 23

4. One mole of an ideal gas at 25°C is expanded isothermally and reversibly from 125.0 L to 250.0 L. Which statement is correct?
(A) $\Delta S_{gas} = 0$ (B) $\Delta S_{univ} = 0$ (C) $\Delta S_{surr} = 0$ (D) $\Delta S_{gas} = R\ln 2$ (E) $\Delta S_{univ} = R\ln 2$

5. In which case must a reaction be spontaneous at all temperatures?
(A) ΔH is positive, ΔS is positive (B) $\Delta H = 0$, ΔS is negative (C) $\Delta S = 0$, ΔH is positive
(D) ΔH is negative, ΔS is positive (E) ΔH is negative, ΔS is negative

6. Consider the titration of 100.0 mL of 0.0500M H_3X (pK_{a1}=3.0, pK_{a2}=7.0, pK_{a3}=12.0) with 0.100 M NaOH. Calculate the pH after the addition of 75.0 mL NaOH.
(A) 3 (B) 5 (C) 7 (D) 9.5 (E) 12

7. The acids HCN and HF are both weak, but HF is a stronger acid than HCN. Order the following according to base strength.
(A) $CN^- > F^- > Cl^- > H_2O$ (B) $CN^- > F^- > H_2O > Cl^-$ (C) $F^- > Cl^- > H_2O > CN^-$
(D) $Cl^- > H_2O > CN^- > F^-$ (E) $F^- > CN^- > Cl^- > H_2O$

8. Given: $Cu_2O(s) + (1/2)O_2(g) \rightarrow 2CuO(s)$ $\Delta H° = -144$ kJ
$Cu_2O(s) \rightarrow Cu(s) + CuO(s))$ $\Delta H° = +11$ kJ
Calculate the standard enthalpy of formation of $CuO(s)$
(A) −166 kJ (B) −299 kJ (C) +299 kJ (D) +155 kJ (E) −155 kJ

9. From the following list of observations, choose the one that most clearly supports the conclusion that the mass of the atom is located mainly in the nucleus
(A) the emission spectrum of hydrogen (B) cathode "rays" (C) diffraction
(D) the scattering of alpha particles by metal foil (E) the photoelectric effect

10. For which of the following transitions does the light emitted have the longest wavelength?
(A) $n = 4$ to $n = 3$ (B) $n = 4$ to $n = 2$ (C) $n = 4$ to $n = 1$ (D) $n = 3$ to $n = 2$ (E) $n = 2$ to $n = 1$

11. In which orbital does an electron experience the highest Z_{eff}?
(A) Na (3s) (B) Mg (3s) (C) Al (3p) (D) P (3p) (E) S (3p)

12. How many electrons can be contained in all of the orbitals with $n = 4$?
(A) 2 (B)8 (C) 10 (D)18 (E) 32

13. Specify the hybridization of the nitrogen atom in each of the following, in order: NO_3^-, N_2, NO_2^-
(A) sp^3, sp, sp^2 (B) sp^2, sp, sp^2 (C) sp^2, sp, sp^3 (D) sp^3, sp^2, sp^3 (E) sp^3, sp^2, sp^2

14. 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) $k[A][B]^2$ (C) $k[A]^2[B]^2$ (D) $k[A][B]$ (E) $k[A]^2[B]$

15. Which of the following is the correct order of boiling points for $NaNO_3$, C_2H_5OH, C_2H_6, and Cl_2?
(A) $Cl_2 < C_2H_5OH < C_2H_6 < NaNO_3$ (B) $NaNO_3 < C_2H_5OH < C_2H_6 < Cl_2$
(C) $Cl_2 < C_2H_6 < NaNO_3 < C_2H_5OH$ (D) $Cl_2 < C_2H_6 < C_2H_5OH < NaNO_3$
(E) $C_2H_6 < Cl_2 < C_2H_5OH < NaNO_3$

16. The deciding factor that makes HF a weak acid is that
(A) HF has a large bond energy. (B) the enthalpy of hydration of F^- is negative
(C) F_2 has a small bond energy. (D) F^- has the largest ionization energy of all the halide ions.
(E) the entropy for hydration of F^- is a large negative value.

17. Which of the following complexes are paramagnetic?
I. $[Fe(H_2O)_6]^{2+}$ II. $[Cr(CN)_6]^{4-}$ III. $[Co(NH_3)_6]^{3+}$ IV. $[CoF_6]^{3-}$ V. $[Fe(CN)_6]^{4-}$ VI. $[Pt(CN)_4]^{2-}$
(A) I, II, IV (B) I, III, VI (C) II, V, VI (D) I, V, VI (E) III, V, VI

18. The most likely decay mode (or modes) of the unstable nuclide $^{11}_{6}C$ would be
I. electron capture II.α decay, III. β decay, IV. positron emission
(A) I, III (B) I, IV (C) II, III (D) III, IV (E) II, IV

19. How many isomers are in the pentoses (aldehyde form)?
(A) 2 (B) 4 (C) 6 (D) 8 (E) 16

20. Aspirin (acetylsalicylic acid) is formed via a(n) _____ reaction of salicylic acid and acetic acid.
(A) addition (B) combustion (C) condensation (D) hydrogenation (E) substitution

二、簡答題: (40%，每題 4 分)

1. Calculate the potential for the half-reaction: $CuI + e^- \rightarrow Cu + I^-$.
(CuI, $K_{sp}=1.0 \times 10^{-12}$; $Cu^+ + e^- \rightarrow Cu$ $E^0=0.52$ V)
2. Why the order of reducing ability is Li > K > Na when these alkaline metals react in aqueous solution, not K > Na > Li in non-aqueous solution.
3. Draw the shape of the molecule, SF_4, and indicate the polarity and hybridization of S atom.

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4. Use the MO enegy-level diagram (basis set: C: 2s, 2p; O: 2s, 2p) to explain that the CO has a triple bond.
5. Why the C-H bond has higher vibraional frequency than that for C-O bond?
6. The reaction $2\ NO_2Cl\ (g) \rightarrow 2\ NO_2 + Cl_2\ (g)$ by the following mechanism:

$$\mathbf{NO_2Cl} \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} \mathbf{NO_2 + Cl}$$

$$\mathbf{NO_2Cl + Cl} \xrightarrow{k_2} \mathbf{NO_2 + Cl_2}$$

   Calculate the concentration of [Cl] at steady-state.
7. The edge length of the MnO unit cell (a NaCl structure) is 447 pm and the ionic radius of O^{2-} is 140 pm. Estimate the ionic radius of Mn^{2+} in pm.
8. The observed osmotic pressure for a 0.10 M solution of $Co(NH_4)_2(SO_4)_2$ at 298 K is 8.00 atm. Calculate the experimental van't Hoff factor. (R = 0.082 L·atm / mol·K)
9. Qualitatively sketch the crystal field splitting of d-orbitals (d_{xy}, d_{xz}, d_{yz}, $d_{x^2-y^2}$, d_{z^2}) for a linear complex with ligands on the z-axis.
10. Draw the structure of 2,6-diisopropylphenol.