國立臺北科技大學 102 學年度碩士班招生考試

系所組別：3620 生化與生醫工程研究所乙組

第一節　普通化學　試題

注意事項：

1. 本試題共 40 題，配分共 100 分，每題 2.5 分。
2. 請標明題號依序作答，不必抄題。
3. 每題為單選題，若有計算時請選擇最接近之數值作為答案。
4. 全部答案，均須在答案卷之答案欄內作答，否則不予計分。

1. Calculate the amount of energy (**kJ**) necessary to raise the temperature of 1 cup of water at 23 C to steam at 105 C. The specific heat capacity of water is 4.184 $J{\cdot}K^{-1}{\cdot}g^{-1}$ and the specific heat capacity of steam is 4.215 $J{\cdot}K^{-1}{\cdot}g^{-1}$. The density of water can be assumed to be 1.00 $g{\cdot}ml^{-1}$. For water, H_{vap} = 40.66 $kJ{\cdot}mol^{-1}$. 1 cup = 0.2366 L.
   a) 81.2　　b) 122　　c) 534　　d) 616
2. Find the (integer) stoichiometry coefficients for the correctly balanced version of the following reaction: $IO_3^-(aq) + S_2O_3^{2-}(aq) + H^+(aq) \rightarrow I^-(aq) + S_4O_7^{2-}(aq) + H_2O(l)$
   a) 1, 3, 3, 1, 3, 3　　b) 6, 2, 6, 6, 1, 3　　c) 2, 3, 3, 1, 1, 9　　d) 2, 6, 6, 2, 3, 3
3. Determine the electron geometry (**eg**) and molecular geometry (**mg**) of ICl_4^{1-}.
   a) **eg** = octahedral, **mg** = square planar
   b) **eg** = linear, **mg** = linear
   c) **eg** = tetrahedral, **mg** = bent
   d) **eg** = trigonal bipyramidal, **mg** = tetrahedral
4. How many polar molecules are for the following? PCl_5, COS, XeO_3, $SeBr_2$
   a) 1　　b) 2　　c) 3　　d) 4
5. What is the hybridization for the Br atom on BrO_4^- structure?
   a) *sp*　　b) sp^2　　c) sp^3d　　d) sp^3
6. Using the **VSEPR** model, what is the electron-domain geometry for the central atom in BF_3?.
   a) linear　　b) trigonal planar　　c) tetrahedral　　d) trigonal bipyramidal
7. Use the bond energies provided to estimate $\Delta H°_{rxn}$ (**kJ**) for the reaction as below:
   $XeF_2 + 2\ F_2 \rightarrow XeF_6$　(Bond energies : Xe–F, 147 **kJ/mol**; F–F, 159 **kJ/mol**.)
   a) – 429　　b) – 660　　c) + 176　　d) – 270
8. How many lone pairs of electrons are on the S atom in SF_4?
   a) 3　　b) 2　　c) 1　　d) 0
9. Determine the energy (**J**) change associated with the transition from **n = 2** to **n = 5** in the hydrogen atom.　$E\mathbf{n} = -2.18 \times 10^{-18}\ \mathbf{J}\ (1/\mathbf{n}^2)$
   a) -2.18×10^{-19}　　b) $+4.58 \times 10^{-19}$　　c) $+3.76 \times 10^{-19}$　　d) -1.53×10^{-19}
10. Which is the numbers of magnetic quantum number (m*l*) for a *d* orbital?
    a) 0, 1, 2, 3, 4　　b) 1, 2, 3, 4, 5　　c) 1, 2, 3　　d) –2, –1, 0, 1, 2
11. Which is the ground state electron configuration for Se?
    a) $[Ar]4s^23d^{10}4p^4$　　b) $[Ar]4s^24d^{10}4p^4$　　c) $[Ar]4s^23d^{10}4p^6$　　d) $[Ar]4s^23d^{10}$
12. Which is the ground state electron configuration for Cr^{3+} ?
    a) $[Ar]4s^13d^2$　　b) $[Ar]4s^23d^6$　　c) $[Ar]3d^3$　　d) $[Ar]4s^23d^1$
13. Which of the following signs on ***q*** and ***w*** represents a system that is doing work on the surroundings, as well as losing heat to the surroundings?
    a) $q = +, w = +$　　b) $q = -, w = -$　　c) $q = -, w = +$　　d) $q = +, w = -$
14. A 21.8 g sample of ethanol (C_2H_5OH) is burned in a bomb calorimeter, according to the following reaction. If the temperature rises from 25.0 to 62.3 °C, determine the heat capacity (kJ/°C) of the calorimeter. (C =12.01, H = 1.008, O = 16.00)
    $C_2H_5OH_{(l)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)}$　$\Delta H°_{rxn} = \mathbf{-1235}$ kJ
    a) 5.65　　b) 63.7　　c) 33.1　　d) 15.7
15. How much energy (**kJ**) is evolved during the reaction of 48.7 g of Al and under an excess of Fe_2O_3, according to the reaction below? (Al = 26.98, Fe = 55.85, O = 16.00)
    $Fe_2O_3(s) + 2\ Al(s) \rightarrow Al_2O_3(s) + 2\ Fe(s)$, $\Delta H°_{rxn} = \mathbf{-852\ kJ}$
    a) 415　　b) 769　　c) 241　　d) 130
16. Balance the following equation and determine the volume (L) of O_2 (at STP) formed when 50.0 g of $KClO_3$ decomposes according to the following reaction. (The molar mass for $KClO_3$ is **122.55 g/mol**.) **A** $KClO_3(s) \rightarrow$ **B** $KCl(s)$ + **C** $O_2(g)$
    a) 9.14　　b) 8.22　　c) 12.3　　d) 13.7
17. Balance the following reaction. How many moles of oxygen are required to produce 2.33 moles of water? Assume that C_3H_7SH is in an excess.
    A $C_3H_7SH(l)$ + **B** $O_2(g) \rightarrow$ **C** $CO_2(g)$ + **D** $SO_2(g)$ + **E** $H_2O(g)$
    a) 3.50　　b) 2.33　　c) 4.14　　d) 6.21
18. Which of the following is a molecular compound?
    a) LiOH　　b) SrI_2　　c) ZnS　　d) P_4O_{10}
19. Give the formula for sodium perchlorate.
    a) NaClO　　b) $NaClO_2$　　c) $NaClO_3$　　d) $NaClO_4$

注意：背面尚有試題

20. Use the standard half-cell potentials listed below to calculate the standard cell potential (V) for the following reaction occurring in an electrochemical cell at 25 °C. (The equation is balanced.)

$3\ Cl_2(g) + 2\ Fe(s) \rightarrow 6\ Cl^-(aq) + 2\ Fe^{3+}(aq)$

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$ $E° = +1.36$ V

$Fe^{3+}(aq) + 3e^- \rightarrow Fe(s)$ $E° = -0.036$ V

a) 1.40 b) 4.16 c) −1.32 d) 1.32

21. Which of the following processes have a $\Delta S > 0$?

a) $CH_3OH(l) \rightarrow CH_3OH(s)$

b) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

c) $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3\ H_2(g)$

d) $Na_2CO_3(s) + H_2O(g) + CO_2(g) \rightarrow 2\ NaHCO_3(s)$

22. Consider the titration of 50.00 ml of 0.100 M hypochlorous acid ($K_a = 3.5 \times 10^{-8}$) with 0.200 M sodium hydroxide. What is the pH of the solution when 15.00 ml of sodium hydroxide has been added?

a) 7.28 b) 7.64 c) 6.72 d) 7.76

23. If a solution contains 0.010 M Pb^{2+} and 0.050 M Mg^{2+}, in order to precipitate the Pb^{2+} as $Pb(OH)_2$ ($K_{sp} = 1.2 \times 10^{-15}$) but not the Mg^{2+} as $Mg(OH)_2$ ($K_{sp} = 1.8 \times 10^{-11}$), what should the pH of the solution be adjusted to?

a) 6.46 b) 4.72 c) 8.60 d) 9.28

24. Why are the oxides of nonmetals usually acidic oxides?

a) The acidic oxides are ionic compounds with an oxide ion, which can react with acid to form a hydroxide ion and then a water molecule.

b) The high electronegativity of the oxygen makes the covalent bond polar with oxygen having a partial negative charge, which makes it react to produce oxoacids.

c) The acidic oxides are compounds of oxygen with atoms of a much lower electronegativity, which leads to the formation of an ionic compound with oxide ions.

d) The oxygen atom in an acidic oxide dissociates and reacts with acids to produce hydroxide ions, which immediately react with any acid present to neutralize the acid.

25. The decomposition reaction of NO_2 is important in atmospheric chemistry. The reaction is second order with respect to NO_2. How can the rate constant be determined?

$2NO_2(g) \rightarrow 2NO(g) + O_2(g)$

a) A plot of $1/[NO_2]$ versus time will be linear with a slope of k.

b) A plot of $\ln[NO_2]$ versus time will be linear with a slope of – k.

c) A plot of $1/[NO_2]$ versus time will be linear with a slope of – k.

d) A plot of $[NO_2]$ versus time will be linear with a slope of – k.

26. Carbon–14 can be used for dating many objects. If a modern sample has a decay rate of 15 dpm/g of carbon, and carbon–14 has a half-life of 5730 years, how old (years) would a sample be that had a decay rate of 4.3 dpm/g of carbon?

a) 89 b) 10,300 c) 19,000 d) 1600

27. The reaction of carbon monoxide with nitrogen dioxide has a rate constant of 0.028 at 300 °C and 1.3 at 400 °C. What is the activation energy (**kJ/mol**) of this reaction?

a) 14.7 b) 123 c) 197 d) 38.3

28. How does a catalyst increase the rate of a chemical reaction?

a) A catalyst increases the probability of a reactive collision.

b) A catalyst increases the energy of the reactants.

c) A catalyst lowers the activation energy of the reaction.

d) A catalyst lowers the energy of the products.

29. Which of the following is **NOT** true about an enzyme-catalyzed reaction?

a) Rates are increased by enormous factors.

b) Reactions are very substrate specific.

c) Inhibitors can reduce the rates of reaction.

d) Many substrates react with a given enzyme.

30. Which of the following solutions is a good buffer system?

a) A solution that is 0.10 M $HC_2H_3O_2$ and 0.10 M $LiC_2H_3O_2$.

b) A solution that is 0.10 M HF and 0.10 M $NaC_2H_3O_2$.

c) A solution that is 0.10 M HCl and 0.10 M NH_4^+.

d) A solution that is 0.10 M NaOH and 0.10 M KOH.

31. You wish to prepare an $HC_2H_3O_2$ buffer with a pH of 5.44. If the pK_a of is 4.74, what ratio of $C_2H_3O_2^-/HC_2H_3O_2$ must you use?

a) 0.70 b) 0.20 c) 1.4 d) 5.0

32. Calculate the pH of a solution formed by mixing 250.0 mL of 0.15 M NH_4Cl with 100.0 mL of 0.20 M NH_3. (The K_b for NH_3 is 1.8×10^{-5}.)

a) 9.25 b) 9.53 c) 4.74 d) 8.98

33. Which of the following is **TRUE**?

a) An effective buffer has a [base]/[acid] ratio in the range of 1~1000.

b) A buffer is most resistant to pH change when [acid] = [conjugate base].

c) An effective buffer has very small absolute concentrations of acid and conjugate base.

d) A buffer **can not be** destroyed by adding too much strong base. But it can only be destroyed by adding too much strong acid.

34. A dilute sugar solution (0.0025 M) is separated from pure water by a semipermeable membrane so that an osmotic pressure is established. What is the osmotic pressure (Torr) at 25 °C? **(R = 0.08206 L·atm/mol·K)**

    a) 123 b) 0.0645 (c) 46.4 (d) 12.3

35. The following reaction obeys **first order** kinetics. After 340 seconds at 800 K, a measurement shows that the concentration of C_2H_5Cl decreased from 0.0098 mol·L^{-1} to 0.0016 mol·L^{-1}. What is the value of the rate constant at 800 K?

    $C_2H_5Cl(g) \rightarrow C_2H_4(g) + HCl(g)$

    a) 7.4×10^{-4} b) 2.3×10^{-3} c) 2.0×10^{-4} d) 1.4×10^{-3}

36. The Beer-Lambert law states what is concentration directly proportional to?

    a) absorbance b) transmittance c) molar absorptivity d) path length.

37. Silicon, a semiconductor, has four valence electrons. Titanium, a conductor, also has four valence electrons. Despite both having four electrons, the elements differ in their conductivity because:

    a) Ti atoms are smaller than Si atoms.

    b) The band gap energies fall sharply in from the third period to the fourth period on the periodic table.

    c) Ti has low-lying d orbitals that form a conduction band, Si does not.

    d) Ti has the larger ionization energy than that of Si.

38. What is different for the isotactic, syndiotactic, and atactic forms of polypropylene?

    a) The functional groups they contain around the carbon backbone.

    b) The terminating functional groups they contain.

    c) The positions of the methyl groups around the carbon backbone.

    d) The number of methyl groups around the carbon backbone.

39. The reaction: $PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$, has a $\Delta S°$ of **–170.2** J/mol·K and a $\Delta H°$ of **– 87.9** kJ/mol. Assuming the values of $\Delta H°$ and $\Delta S°$ are constant, at what temperature does the reaction become nonspontaneous?

    a) 516.5 °C b) 1663.3 °C c) 789.6 °C d) 243.3 °C

40. If 40.0 g of benzene reacts with an excess of chlorine to give 51.6 g of chlorobenzene, what was the percent yield (%)? **($C_6H_6(l) + Cl_2(g) \rightarrow C_6H_5Cl(l) + HCl(g)$.)**

    (C = 12.01, H = 1.008, O = 16.00, Cl = 35.45)

    a) 77.5 b) 89.5 c) 53.8 d) 69.4