國立成功大學

110學年度碩士班招生考試試題

編　號：94

系　所：材料科學及工程學系(綠色應用材料碩士班)

科　目：化學

日　期：0203

節　次：第 2 節

備　註：可使用計算機

編號： 94　　國立成功大學 110 學年度碩士班招生考試試題

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

化學共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

1. Which of the following is classified as a metal?
   (a) Ge　(b) As　(c) Ar　(d) V.

2. Hydrogen cyanide is produced industrially by the following exothermic reaction.

$$2NH_3(g) + 3O_2(g) + 2CH_4(g) \xrightarrow[\text{Pt-Rh}]{1000^\circ C} 2HCN(g) + 6H_2O(g)$$

   The high temperature is needed for
   (a) thermodynamic,　(b) catalytic,　(c) kinetic,　(d) decomposition reasons,　(e) esterification.

3. Considering an electron to be added to a gas-phase atom,
   (a) it always requires energy release and is related to electron affinity.
   (b) it always requires energy supply and is related to electron affinity.
   (c) it is known that less energy will be needed to make O^{2-} from O^- than to make F^{2-} from F^-.
   (d) it is related to electron affinity which is highest toward the left of the periodic table.

4. Which one of the following reactions is the case that a system does work on surrounding?
   (a) $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$
   (b) $Cl_{2(g)} + H_{2(g)} \rightarrow 2HCl_{(g)}$
   (c) $Xe_{(g)} + F_{2(g)} \rightarrow XeF_{2(s)}$
   (d) $Al_2O_{3(s)} + 3H_{2(g)} \rightarrow 2Al_{(s)} + 3H_2O_{(g)}$
   (e) $NiCl_2 \cdot 6H_2O_{(s)} \rightarrow NiCl_{2(s)} + 6H_2O_{(g)}$

5. Please identify the electron configuration of Co^{2+} (Hint: atomic number of Co: 27).
   (a) $[Ar]4s^23d^7$.　(b) $[Ar]3d^7$.　(c) $[Ar]4s^13d^6$.　(d) $[Ar]4s^23d^5$.　(e) $[Ar]4s^13d^5$.

6. What is the type of interparticle force presents in $CaCl_2$?
   (a) dipole　(b) ionic　(c) hydrogen bonding　(d) covalent　(e) London dispersion.

7. Which one of the following statements is TRUE?
   (a) One mole of any acid will ionize completely in aqueous solution to produce one mole of H^+ ions.
   (b) Solutions of weak acids always have lower concentrations of H^+ than solutions of strong acids.
   (c) There are several common acids that are insoluble.
   (d) All of the IA and IIA metal hydroxides are soluble.

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8. Compare the acidity of the following compounds in increasing order.
   (1)$RCH{=}CH{-}H$, (2)$RCH_2CH_2{-}H$, (3)$RC{\equiv}C{-}H$
   (a) 1 < 2 < 3, (b) 3 < 2 < 1, (c) 1 < 3 < 2, (d) 2 < 1 < 3, (e) 2 < 3 < 1.

9. The octet rule is widely satisfied, and we also find complete octet in
   (a) radicals and biradicals. (b) the B atom of NH_3BF_3 molecules
   (c) the B atom of BF_3 molecules. (d) the P atom of PCl_5 molecule.

10. Which of the following pair of elements should combine to give covalent compound?
    (a) Cu + Sn (b) Cl_2 + Cr (c) $N_2 + O_2$ (d) $S_8 + Na_2$ (e) $Na_2 + Cl_2$.

11. Which name/formula combination is WRONG?
    (a) chlorous acid / $HClO_2$ (b) dinitrogen tetroxide / N_2O_4
    (c) ammonium nitrate / NH_4NO_3 (d) copper(II) periodate / $CuIO_4$.

12. Arrange the ion size in decreasing order.
    (a) $Ba^{2+}>Cs^{+}>I^{-}>Te^{2-}$ (b) $Te^{2-}>Cs^{+}>Ba^{2+}>I^{-}$ (c) $Te^{2-}>I^{-}>Cs^{+}>Ba^{2+}$ (d) $Cs^{+}>Ba^{2+}>I^{-}>Te^{2-}$ (e) $I^{-}>Cs^{+}>Te^{2-}>Ba^{2+}$

13. For the electrical conductivity of aqueous solutions,
    (a) it arises from the presence of ions . (b) the addition of sugar is able to increase the conductivity.
    (c) it is independent of dissolved solutes. (d) it is independent of salt concentration.

14. In a chamber separated by a movable wall, we put the same weights of four gases, CO_2, NH_3, O_2, and N_2, into one of the two separated rooms at the same temperature. The wall is locked first to hold its position and let go when filled by gases. After release the door, which one of the four gases will move the wall in the highest speed?
    (a) CO_2 (b) NH_3 (c) O_2 (d) N_2.

15. The auto-ionization constant of water is 2.09×10^{-14} at 35°C. What is the pH of pure water at 35°C?
    (a) 7 (b) 6.84 (c) 7.36 (d) 7.16 (e) 6.5

16. Please predict the number of unpaired electrons of O_2^{+}.
    (a) 0. (b) 1. (c) 2. (d) 3. (e) None.

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17. For the acid-base reaction,
    (a) an acid is a proton acceptor.
    (b) a base is a substance that produces H^+ ions.
    (c) an acid is a substance that gives proton.
    (d) the $HC_2H_3O_2$ molecules are able to serve as proton acceptors in water with the dissolution of KOH.

18. Magnesium $[Ne]3s^2$ has 2 valence electrons in its outer shell orbitals. In the cubic-like rocksalt MgO crystal, magnesium and oxygen are both surrounded by the other atoms, what the bonding geometry of MgO crystal do you expect?
    (a) Linear　(b) Trigonal　(c) Tetrahedral　(d) Hexagonal　(e) Octahedral.

19. A protamine of 1 mg is dissolved in water to make 1.0 mL of solution. The osmotic pressure of this solution is 1.5 torr at 30°C. What is the molar mass of this protamine?
    (a) 2.5×10^4　(b) 8.2×10^3　(c) 1.26×10^4　(d) 2.9×10^4　(e) 3.2×10^4.

20. Which one of the following is likely to be the most soluble base?
    (a) $Ca(OH)_2$　(b) $Cu(OH)_2$　(c) $Ga(OH)_3$　(d) $Zn(OH)_2$.

21. Bond angle of CS_2 is
    (a) 180,　(b) 120,　(c) 109.5,　(d) 90,　(e) 60　degree.

22. Which of the followings contains the smallest number of water molecules?
    (a) 1.0 g of liquid water at 0°C　(b) 1.0 g of solid water at 0°C　(c) 1.0 ml of solid water at 0°C
    (d) 1.0 ml of liquid water at 0°C　(e) 1.0 ml of liquid water at 4°C.

23. Which of the following is NOT directly necessary for protein synthesis:
    (a) ribosomes　(b) mRNA　(c) DNA　(d) polypeptide　(e) amino acids.

24. Henry's law correlates the amount of gas dissolved in a solution with the pressure of gas above the solution. Which of the following gas does follow Henry's law when dissolves in water?
    (a) SO_2　(b) NH_3　(c) HCl　(d) CO_2　(e) N_2.

25. The limiting reagent in a chemical reaction is one that:
    (a) has the largest molar mass (formula weight).　(b) has the smallest molar mass (formula weight).
    (c) has the smallest coefficient.　(d) is consumed completely.

26. Which ions, Rb^{+}, Sr^{2+}, and Y^{3+}, is the largest?
(a) Sr^{2+}. (b) Y^{3+}. (c) The same. (d) Rb^{+}. (e) Cannot compare.

27. Which of the following statements is correct?
(a) Galvanic cell needs exterior electric current for the redox reaction
(b) Galvanic cell provides electric current
(c) electrolytic cell produces electric current
(d) Galvanic cell does not involve redox reaction
(e) electrolytic cell does not involve redox reaction.

28. Diamond is the hardest naturally occurring substance because the structure is stabilized by
(a) covalent bonds (b) metallic bonds (c) ionic bonds (d) van der Waal force (e) none of above.

29. What alkaline earth metal is located in period 3?
(a) Na (b) Ca (c) Sr (d) Mg.

30. Which of the following has the highest boiling point?
(a) propane($CH_3CH_2CH_3$) (b) dimethyl ether(CH_3OCH_3) (c) ethane (CH_3CH_3)
(d) ethanol (CH_3CH_2OH) (e) n-pentane($CH_3CH_2CH_2CH_2CH_3$).

31. The equilibrium K values for the Ammonia synthesis reaction are 90, 3, and 0.3, respectively, at 500K, 600K, and 700K. Which of the following statements is correct?
(a) the synthesis reaction is endothermic
(b) the synthesis reaction is exothermic
(c) the process should be conducted at higher temperature to favor the reaction
(d) temperature is irrelevant to the fraction of production
(e)the process should be conducted under warm bath to enable the reaction.

32. NH_3 having the structure of
(a) planar, (b) tetrahedral, (c) linear, (d) triangle, (e) square.

33. A 32 g of NH_4NO_2 is heated in a test tube. The reaction is as follows: $NH_4NO_{2(s)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$. How much N_2 will be collected in a flask when the reaction occurs at 27 °C and 745 mmHg?
(a) 1 mole. (b) 0.5 mole. (c) 0.05 mole. (d) 2 mole. (e) 0.25 mole.

34. What is the status of a solution in an equilibrium with undissolved solute?
(a) Supersaturated. (b) Miscible. (c) Saturated. (d) Immiscible. (e) Freeze.

35. As following equation, if 25ml of NO_2 gas is completely converted to N_2O_4 gas under the same conditions, volume of N_2O_4 should be (a) 25, (b) 10.5, (c) 50, (d) 10, (e) 12.5 ml.

$$2NO_2(g) \longrightarrow N_2O_4(g)$$

36. For the bond strength, which of the following description is wrong?
(a) It is measured by dissociation energy.
(b) A double bond between two carbon atoms is twice as strong as a single bond.
(c) The presence of lone pairs of electron is able to influence bond strength.
(d) The trends in bond strength correlates with trends in atomic radii.

37. What is the pH of a 1.0 M methylamine (k_b is 4.38×10^{-4}) solution?
(a) 12.32 (b) 7 (c) 10 (d) 2.1×10^{-2} (e) 5.32

38. For the following descriptions of enthalpy or entropy, which one is NOT correct?
(a) The magnitude of ΔH is directly proportional to the quantities of reactants and products in a reaction
(b) Hess's law can be used to reduce the steps of overall reaction
(c) If a reaction is reversed, the sign of ΔH is also reversed
(d) Entropy is a not state function
(e) In statistical mechanics, entropy is an extensive property of a thermodynamic system.

39. A solution is prepared by mixing 20 mL of Methanol (density=0.79 g/cm^3) with 30 mL ethanol (density=0.79 g/cm^3) and 50 mL water (density=1.0 g/cm^3). What is the molarity of the ethanol?
(a) 5.8 mol/kg (b) 6.5 mol/L (c) 7.3 mol/kg (d) 5.2 mol/L (e) 5.8 mol/L.

40. For an ionic solid dissolves in water,
(a) it breaks up into aggregates of cations and anions, and disappears.
(b) the negative ends of water molecules will surround and enclose the negatively charged ions.
(c) the hydrogen atoms of water molecules are attracted to the negatively charged anions
(d) the solubility depends on the relative affinities of the ions for each other.

41. How many isomers of pentane?
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5.

42. In H_2CO_3 solution, the fraction of dissociation species will change with respect to pH value. Which of the following species has the highest fraction at very high pH value solution?
(a) CO_3^{2-} (b) HCO_3^- (c) H_2CO_3 (d) $H_3CO_3^+$ (e) H_2CO_3+HCO_3^-.

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43. At standard condition, 25 °C and 1 atm per mole, which one of the following reactions will give $\Delta S_0 > 0$? S_0 denotes the entropy of materials in standard condition.

(a) $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$

(b) $CS_{2(g)} + 3O_{2(g)} \rightarrow CO_{2(g)} + 2SO_{2(g)}$

(c) $3O_{2(g)} \rightarrow 2O_{3(g)}$

(d) $Al_2O_{3(s)} + 3H_{2(g)} \rightarrow 2Al_{(s)} + 3H_2O_{(g)}$

(e) $2Al_{(s)} + 3Br_{2(l)} \rightarrow 2AlBr_{3(s)}$.

44. Given $G = H - TS$, G, T, H and S denote free energy, temperature, system enthalpy, and entropy. Which following situation will give a spontaneous process for the system at constant pressure and temperature?

(a) heat flows out of the system and $\Delta S < 0$

(b) heat flows in the system and $\Delta S < 0$

(c) heat flows out of the system and $\Delta S > 0$

(d) heat flows in the system and $\Delta S > 0$

(e) $\Delta G > 0$.

45. For three types of chemical equation used to describe reactions in solution,

(a) the molecular equation gives the overall reaction stoichiometry, and the actual forms of the reactants and products in solution.

(b) all substances that are strong electrolytes are represented as ions in a complete ionic equation.

(c) The complete ionic equation reveals all the ions that participate in the reactions.

(d) The net ionic equation includes all the solution components that undergo a change.

46. What is the molality of a solution labeled "8.6% glucose (C6H12O6) by weight?" (Note: If the question does not give the solvent, assume it is water.)

(a) 0.26 m　　(b) 0.34 m　　(c) 0.44 m　　(d) 0.52 m.

47. Which of the following is the most basic oxide?

(a) Bi_2O_5　　(b) N_2O_3　　(c) P_4O_6　　(d) P_4O_{10}.

48. For real gases, we can approximate their non-ideal behaviors by van der Waals fluid equation, $[P + a(n/V)^2](V - nb) = nRT$, a and b are constants. After applying pressure onto the piston, for methane, ethane, propane, butane, and pentane with the same n moles, which gas do you expect to see condensation first?

(a) Methane　　(b) Ethane　　(c) Propane　　(d) Butane　　(e) Pentane

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49. Please calculate the molarity (M) of a commercial bleach solution of 500 ml that contains 6.3 g of CaCl(OCl). Hint: masses of Ca, Cl, and O are 40, 35, and 12, respectively.

(a) 0.0001 M.　(b) 0.013 M.　(c) 0.5 M.　(d) 0.1 M.　(e) 0.25 M.

50. In the following electromagnetic wavelengths, which one is the shortest wavelength in meters?

(a) infrared　(b) radar　(c) FM radio waves　(d) visible red　(e) X-ray.