

八十六學年度 化學系 系(所) 化學 組碩士班研究生入學考試  
 科目 綜合化學 科號 0601 共 8 頁第 1 頁 \*請在試卷(答案卷)內作答

單選題，每題二分，不倒扣

- One can get larger particle size for gravimetric analysis experiments by  
 (A) rapid cooling  
 (B) rapid addition of the precipitating reagent  
 (C) addition of the precipitating reagent without stirring  
 (D) precipitation from homogeneous solution
- A buffer solution with a pH of 7.0 is prepared by adding NaOH solution into  $\text{H}_3\text{PO}_4$ . What is the main composition of the solution ( $K_1=7.1\times 10^{-3}$ ,  $K_2=6.3\times 10^{-8}$ ,  $K_3=4.2\times 10^{-13}$  for  $\text{H}_3\text{PO}_4$ )  
 (A)  $\text{H}_3\text{PO}_4$  and  $\text{H}_2\text{PO}_4^-$  (B)  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^{2-}$   
 (C)  $\text{HPO}_4^{2-}$  and  $\text{PO}_4^{3-}$  (D)  $\text{H}_3\text{PO}_4$  and  $\text{PO}_4^{3-}$
- Which of the following statement is not true for a 0.01 M aqueous solution of  $\text{NaHCO}_3$   
 (A)  $0.01 = [\text{H}_2\text{CO}_3] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$   
 (B)  $[\text{H}_3\text{O}^+] = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}] + [\text{OH}^-]$   
 (C)  $[\text{HCO}_3^-] \approx 0.01 \text{ M}$   
 (D)  $[\text{CO}_3^{2-}] \ll [\text{HCO}_3^-]$
- Which of the following statement about atomic absorption spectrometry (AA) is true?  
 (A) the sensitivity attained by the flame AA is generally much greater than that attained by graphite furnace AA  
 (B) spectra interference is generally more significant for graphite furnace AA than that for flame AA  
 (C) the standard addition method is commonly used in AA for the correction of background absorption  
 (D) More elements can be determined by graphite furnace AA than by flame AA

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5. Which of the following techniques can not be used directly to separate chemical species?  
 (A) electrochemical method (B) microwave digestion  
 (C) chromatographic method (D) precipitation
6. The ionic strength of a solution that is both 0.02 M in NaCl and 0.01 M in  $\text{Na}_2\text{SO}_4$  is  
 (A) 0.03 (B) 0.04 (C) 0.05 (D) 0.06
7. Which element in the sample is commonly determined by Kjeldahl method?  
 (A) C (B) S (C) N (D) P
8. When will peptization of precipitate most probably occur  
 (A) wash crystalline precipitate with pure water  
 (B) wash crystalline precipitate with ammonia chloride solution  
 (C) wash colloid precipitate with pure water  
 (D) wash colloid precipitate with ammonia chloride solution
9. Which of the following is not considered as the applications of ion-exchange resins in analytical chemistry.  
 (A) chromatography (B) separation of interfering ions  
 (C) concentration of traces of an ion from solution  
 (D) as a precipitate reagent
10. During the preparation of a permanganate solution for oxidation-reduction titration. The solution was boiled, explain why.  
 (A) to remove carbon dioxide  
 (B) to dissolve permanganate  
 (C) to hasten oxidation of organic matter  
 (D) permanganate solution is more stable at higher temperature

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11. Which of the following statement about buffer solution is not true
  - (A) It resists changes in pH by dilution
  - (B) It resists changes in pH by small addition of acids or bases
  - (C) The most effective buffer solution contain approximately equal concentration of conjugate acid-base pair
  - (D) A concentrate nitric acid is a buffer solution
12. A  $\text{Ba}(\text{OH})_2$  solution was standardized by titration against 0.100 N HCl, 30.0 mL of the base being required to neutralize 40.0 mL of the acid. Calculate the normality (meq/mL) of the  $\text{Ba}(\text{OH})_2$  solution
  - (A) 0.133      (B) 0.266      (C) 0.067      (D) 0.075
13. The normality of a solution is determined by four separate titrations, the results being 0.2043, 0.2039, 0.2049, 0.2041. Calculate the standard deviation
  - (A) 0.0001      (B) 0.0002      (C) 0.0003      (D) 0.0004
14. The correct order of electron affinities is
  - (A)  $\text{F} > \text{Cl} > \text{Br} > \text{I}$       (B)  $\text{Cl} > \text{F} > \text{Br} > \text{I}$       (C)  $\text{Cl} > \text{Br} > \text{F} > \text{I}$
  - (D)  $\text{F} > \text{Br} > \text{Cl} > \text{I}$
15. Which atom has the lowest ionization energy
  - (A) N      (B) O      (C) F      (D) Ne
16. The radius for the Bohr orbital is given
  - (A)  $r = (n^2/z^2)a_0$       (B)  $r = (n/z)a_0$       (C)  $r = (n^2/z)a_0$
  - (D)  $r = (n/z^2)a_0$

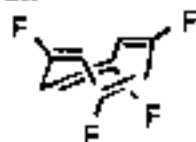
where  $n$  is the quantum number,  $z$  is nuclear charge and  $a_0$  is the Bohr radius for the hydrogen atom

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17. The pressure of gas is in proportional to  
 (A) speed  $\bar{c}$  (B) momentum  $m\bar{c}$  (C) kinetic energy  $m\bar{c}^2$   
 (D)  $(\bar{c}^2)^{3/2}$  of the gas molecule.  
 $\bar{x}$  is the average value for  $x$ .
18. The Maxwell-Boltzmann gas speed ( $c$ ) distribution function  $\Delta N/N$  is in proportional to  
 (A)  $e^{-mc^2/2kT}$  (B)  $ce^{-mc^2/2kT}$  (C)  $c^2e^{-mc^2/2kT}$   
 (D)  $c^3e^{-mc^2/2kT}$
19. Which molecule has the largest value of constant  $a$  in the van der Waals equation  $P = RT/(v-b) - a/v^2$   
 (A)  $H_2$  (B)  $N_2$  (C)  $CH_4$  (D)  $CO_2$
20. Which molecule (above four molecules) has the lowest critical temperature.
21. The pressure of one atmosphere is about  
 (A) 5 meters (B) 10 meters (C) 20 meters  
 (D) 40 meters of water
22. Which condition is satisfied by an ideal solution for mixing A and B  
 (A)  $\Delta_{mix}S = 0$  (B)  $\Delta_{mix}G = 0$  (C)  $\Delta_{mix}H = 0$   
 (D)  $\Delta_{mix}V = 0$   
 The quantity  $\Delta_{mix}X$  is the difference in quantity  $X$  after and before the mixing.
23. Which molecule has the largest value (absolute value  $> 0$ ) of enthalpy of combustion  
 (A)  $CH_4$  (B)  $CH_3OH$  (C)  $H_2CO$  (D)  $HCOOH$

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24. Which molecule has the longest bond distance  
 (A)  $O_2^{2-}$  (B)  $O_2^-$  (C)  $O_2$  (D)  $O_2^+$
25. Which molecule has the largest C-H bond dissociation energy  
 (A)  $CH_3-H$  (B)  $(CH_3)_3C-H$  (C)  $CH_2=CH-H$  (D)  $HC\equiv C-H$
26. Which wavelength below is in the visible light region?  
 (A) 50000 nm (B) 5000 nm (C) 500 nm (D) 50 nm
27. If the complex  $[Fe(NO)_2(CO)_3]^z$  is a 18-electron complex, what is the value of the charge? (note Fe-N-O is a linear shape)  
 (A)  $Z = -1$  (B)  $Z = 0$  (C)  $Z = +1$  (D)  $Z = +2$
28. What is the point group of 1,3,5,7-tetrafluorocyclooctatetraene  
 (A)  $C_{2v}$  (B)  $C_{2h}$  (C)  $D_{2d}$  (D)  $S_4$



29. Which statement is not correct.  
 (A) the N-O bond order:  $NO_2^+ > NO_2 > NO_2^-$   
 (B) the O-O bond order:  $O_2 > O_2^- > O_2^{2-}$   
 (C) the C-C bond order:  $C_2 > C_2^- > C_2^{2-}$   
 (D) the N-O bond order:  $NO^+ > NO > NO^-$
30. For complexes such as  $I_3^-$ ,  $N_3^-$ ,  $IF_2^-$ ,  $O_3^+$ , and  $NO_2^+$ , how many of them are bent with respect to triatomic centers  
 (A) 1 (B) 2 (C) 3 (D) 4
31. Which complexes below will have the strongest absorption coefficient in the d-d transition.  
 (A)  $MnF_4^{2-}$  (B)  $Mn(H_2O)_6^{2+}$  (C)  $NiF_4^{2-}$  (D)  $Ni(H_2O)_6^{2+}$

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32. Which compound below will show the largest Jahn-Teller effect  
 (A)  $\text{Cr}(\text{H}_2\text{O})_6^{2+}$  (B)  $\text{Ni}(\text{H}_2\text{O})_6^{2+}$  (C)  $\text{Co}(\text{H}_2\text{O})_6^{3+}$  (D)  $\text{Ti}(\text{H}_2\text{O})_6^{3+}$
33. The ground state term symbol for  $\text{CrF}_6^{3-}$  is  
 (A)  ${}^4\text{A}_{2g}$  (B)  ${}^4\text{T}_{2g}$  (C)  ${}^4\text{T}_{1g}$  (D)  ${}^4\text{E}_g$
34. The metal center in Cytochrome c is  
 (A)  $\text{Fe}^{2+}$  (B)  $\text{Co}^{2+}$  (C)  $\text{Mg}^{2+}$  (D)  $\text{Zn}^{2+}$
35. The W-W bond order in the  $[\text{CpW}(\text{CO})_2]_2$  complex is  
 (A) 1 (B) 2.5 (C) 2 (D) 3
36. Which reaction below will favor the forward reaction?  
 (A)  $\text{TiF}_4 + 2\text{TiI}_2 = \text{TiI}_4 + 2\text{TiF}_2$   
 (B)  $\text{COF}_2 + \text{HgBr}_2 = \text{COBr}_2 + \text{HgF}_2$   
 (C)  $\text{CuI}_2 + 2\text{CuF} = \text{CuF}_2 + 2\text{CuI}$   
 (D)  $\text{CH}_3\text{HgOH} + \text{HSO}_3^- = \text{CH}_3\text{HgSO}_3^- + \text{H}_2\text{O}$
37. Which complexes below has the largest  $10\text{Dq}$  value in the d-orbital splitting  
 (A)  $\text{Co}(\text{NH}_3)_6^{3+}$  (B)  $\text{Co}(\text{NH}_3)_6^{2+}$  (C)  $\text{Ir}(\text{NH}_3)_6^{2+}$  (D)  $\text{Ir}(\text{NH}_3)_6^{3+}$
38. Which of the following cycloalkanes exhibits the greatest molar heat of combustion?  
 (A) cyclopropane (B) cyclobutane (C) cyclopentane  
 (D) cyclohexane
39. Which of the following is a bridged bicyclic alkane?  
 (A) cis-decalin (B) bicyclo[2.2.1]heptane  
 (C) bicyclo[3.2.0]heptane (D) bicyclo[4.1.0]heptane

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40. Which set of reagents will best convert 2,2-dimethylpropanol (neopentyl alcohol) to 4,4-dimethyl-2-pentanol?
- (A) 1. HCl  
 2. Mg  
 3.  $\text{CH}_3\text{CHO}$   
 4.  $\text{H}_3\text{O}^+$
- (B) 1. HCl,  $\text{ZnCl}_2$   
 2. Mg  
 3.  $\text{CH}_2\text{O}$   
 4.  $\text{H}_3\text{O}^+$
- (C) 1.  $\text{SOCl}_2$   
 2. Mg  
 3.  $\text{CH}_3\text{CHO}$   
 4.  $\text{H}_3\text{O}^+$
- (D) 1. HCl,  $\text{ZnCl}_2$   
 2. Mg  
 3.  $\text{CH}_3\text{CHO}$   
 4.  $\text{H}_3\text{O}^+$
41. Absorption of what type electromagnetic radiation results in transitions among allowed nuclear spin states?
- (A) radio wave (B) microwaves (C) ultraviolet light  
 (D) infrared light
42. What multiplicities are observed for the signals in the off-resonance decoupled  $^{13}\text{C}$  spectrum of 2-chloropropene?
- (A) 3 singlets (B) a singlet and 2 doublets  
 (C) a singlet, a doublet, and a triplet  
 (D) a singlet, a triplet, and a quartet
43. Which of the species below is less basic than acetylide?
- (A)  $\text{CH}_3\text{Li}$  (B)  $\text{CH}_3\text{ONa}$  (C)  $\text{CH}_2\text{CHLi}$  (D)  $\text{NaNH}_2$
44. When 1,2-dibromobutane is heated at  $200^\circ\text{C}$  in the presence of molten KOH, what is the major organic product?
- (A) 1-bromo-1-butyne (B) 1-bromo-2-butyne  
 (C) 1-butyne (D) 2-butyne

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45. Which of the following molecules is chiral?  
 (A) 2,3-pentadiene (B) 1,2-pentadiene  
 (C) 2-chloro-4-methyl-2,3-pentadiene  
 (D) all of the above molecules are chiral
46. Which of the following compounds has the highest melting point?  
 (A) toluene (B) o-dichlorobenzene (C) m-dichlorobenzene  
 (D) p-dichlorobenzene
47. Which of the following is not a fused-ring heterocycle?  
 (A) purine (B) pyrimidine (C) benzofuran (D) indole
48. Which of the following compounds is least reactive in the nucleophilic aromatic substitution reaction with NaOH?  
 (A) 2,4-dinitrochlorobenzene (B) 3,5-dinitrochlorobenzene  
 (C) o-nitrochlorobenzene (D) m-nitrochlorobenzene
49. Consider the equilibrium of each of the carbonyl compounds with HCN to produce cyanohydrins. Which is the correct ranking of compounds in order of increasing  $K_{eq}$  for this equilibrium?  
 (A)  $H_2CO < \text{cyclohexanone} < CH_3CHO < 2\text{-methylcyclohexanone}$   
 (B)  $\text{cyclohexanone} < 2\text{-methylcyclohexanone} < H_2CO < CH_3CHO$   
 (C)  $\text{cyclohexanone} < 2\text{-methylcyclohexanone} < CH_3CHO < H_2CO$   
 (D)  $2\text{-methylcyclohexanone} < \text{cyclohexanone} < CH_3CHO < H_2CO$
50. An ylide is a molecule that can be described as a:  
 (A) carbocation bound to a negatively charged heteroatom.  
 (B) carbocation bound to a carbanion.  
 (C) carbocation bound to a diazonium ion.  
 (D) carbanion bound to a positively charged heteroatom.