# 國　立　清　華　大　學　命　題　紙

九十二學年度＿＿化學＿＿系（所）＿化學、應用化學＿組碩士班研究生招生考試

科目 綜合化學_科號_0601, 0701_共＿5＿頁第＿1＿頁 *請在試卷【答案卷】內作答

選擇題 四選一

1. Which statement is incorrect for an ideal solution mixing from 1 mole each of A and B ($\Delta X_{mix}$=X(solution)-X(unmixed))
   (A) no intermolecular interaction between A and B　(B) $\Delta H_{mix}=0$　(C) $\Delta V_{mix}=0$
   (D) $\Delta S_{mix}= -2R\ln(½)$
2. The speed of an electron in the nth Bohr orbital is K time the speed of n=1 where K=
   (A) $\frac{1}{n}$　(B) $\frac{1}{n^2}$　(C) n　(D) $n^2$
3. The reaction mechanism at the low-temperature between $NO_2$ and CO is (1) $NO_2+NO_2\rightarrow NO_3+NO$ (slow) (2) $NO_3+CO\rightarrow NO_2+CO_2$ (fast). The rate law $d[CO_2]/dt$ is expected to be
   (A) $\sim[NO_2]^2$　(B) $\sim[NO_2][CO]$　(C) $\sim[NO_2]^2[CO]$　(D) $\sim[NO_2]$
4. The atom has the highest first ionization energy
   (A) H　(B) He　(C) Mg　(D) Na
5. Which decimal prefix has an incorrect corresponding number
   (A) mega, $1\times10^{6}$　(B) micro, $1\times10^{-5}$　(C) nano, $1\times10^{-9}$　(D) femto, $1\times10^{-15}$
6. The bond of the highest stretching vibrational frequency is
   (A) C-H　(B) O-H　(C) C-Cl　(D) C=C bond
7. The element with the largest electron affinity (absolute value) is
   (A) O　(B) F　(C) Cl　(D) Br
8. For one mole of ideal gas, which equation is incorrect
   (A) $\left(\frac{\partial T}{\partial P}\right)_S=\left(\frac{\partial V}{\partial S}\right)_P$　(B) $\left(\frac{\partial H}{\partial P}\right)_S=V$　(C) $\left(\frac{\partial U}{\partial V}\right)_S=P$　(D) $\left(\frac{\partial U}{\partial S}\right)_V=T$
9. The liquid has the highest surface tension value is
   (A) carbon tetrachloride　(B) glycerol　(C) water　(D) mercury
10. The molecule has the largest value of proton affinity (absolute value)
    (A) HF　(B) $H_2O$　(C) $NH_3$　(D) $CH_4$

11. Which gas has the largest van der Waals constant $a$ $\left(\frac{atm\bullet L^2}{mol^2}\right)$
    (A) $H_2$　(B) $N_2$　(C) $CO_2$　(D) $H_2O$
12. The strongest double bond is
    (A) C=C　(B) C=N　(C) N=N　(D) C=O

13. The half-life ($t_{½}$) of a second-order reaction A+A→B with the rate constant k and the initial concentration $[A]_o$ is
(A) ln2/k (B) $k[A]_o$ (C) $k[A]_o^2$ (D) $1/k[A]_o$

14. Naturally occurring lithium consists of two isotopes: $^6Li$ and $^7Li$. How many neutrons are in each isotope?
(A)6,7, (B)3,3, (C)4,3, (D)3,4,

15. Which of the following MS ionization method was used to imply making the elephant fly?
(A)EI, (B)ESI, (C)FAB, (D)CI

16. An $^{56}Fe^{2+}$ particle contains
(A)26 protons, 26 neutrons, and 26 electrons, (B)28 protons, 28 neutrons, and 26 electrons, (C)26 protons, 30 neutrons, and 24 electrons, (D)54 protons, 56 neutrons, and 52 electrons

17. Which of the following gas is most popular as carrier gas in GC-FID?
(A)He, (B)$H_2$, (C)$N_2$, (D)$O_2$

18. Elements belonging to which group of the periodic table form ions with a 2+ charge?
(A)alkali metals, (B)alkaline earth metals, (C)chalcogens, (D)halogens

19. Complete the following statement: _____ are in 10.0 moles of $C_{10}H_8$.
(A) $6.022 \times 10^{24}$ atoms of C, (B)$4.818 \times 10^{24}$ atoms of H, (C)$4.818 \times 10^{25}$ atoms of H, (D) 10.0 moles of C

20. Ascorbic acid (vitamin C) contains 40.92%C, 4.58%H, and 54.50%O by mass. What is the empirical formula of ascorbic acid?
(A)$C_3H_4O_3$, (B)$C_3H_5O_3$, (C)$C_4H_6O_4$, (D)$C_3H_5O_4$

21. Which reactions will *not* produce a precipitate from aqueous solution?
(A)$AgNO_3 + KI$, (B)$FeSO_4 + Ba(OH)_2$, (C)$NaBr + Al_2(SO_4)_2$, (D)$ZnCl_2 + (NH_4)_2S$

22. Consider the following reactions:

$2AgNO_3(aq) + Zn(s) \rightarrow 2Ag(s) + Zn(NO_3)_2$

$Zn(NO_3)_2(aq) + Co(s) \rightarrow$ no reaction

$2AgNO_3(aq) + Co(s) \rightarrow Co(NO_3)_2(aq) + 2Ag(s)$

Which is the correct order of increasing activity for these metals?
(A)Zn < Co < Ag, (B)Ag < Co < Zn, (C)Co < Zn < Ag, (D)Ag < Zn < Co

23. Among the following metals, which is of least toxicity?
(A)Pb, (B)Cd, (C)Cu, (D)Hg

24. Given the equation

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H? = -571.6$ kJ,

which statement is *incorrect*?

(A)The standard heat of formation of liquid water is -571.6 kJ/mol. (B)$\Delta H°$ for the reverse reaction is +571.6 kJ/mol.(C)$\Delta H°$ for the formation of 1/2 mol of oxygen is 285.8 kJ/mol. (D) The equation forming gaseous water would have a different $\Delta H$.

25. Identify the specific element that corresponds to the following electron configuration:
$[Ne]3s^2 3p^1$
(A)Al, (B)Si, (C)B, (D)Ga

26. Which one is not true?
(A) $O_3$ is bent. (B) $O_3^+$ is bent. (C) Bond angle in $PH_3$ is larger than that in $AsH_3$. (D) $I_3^-$ is bent.

27. What is the point group of $H_3O^+$.
(A)$D_3$ (B) $D_{3d}$ (C) $C_3$ (D) $C_{3v}$.

28. Which one about solubility order is not correct.
(A) AgCl > AgBr (B) $Ag_2S$ > AgCl (C) $Fe(OH)_2 > Fe(OH)_3$ (D) LiCl > LiF

29. Which one is not correct.
(A) Crown ethers have the general formula $(CH_2CH_2O)_n$. (B) A crown ether cab recognize a specific alkali metal ion. (C) Cryptands have the general formula $(CH_2O)_n$. (D) A cryptand can recognize a specific alkali metal ion.

30. Which one is not the product of the following two reactions: heating ammonium nitrate and reaction between $SF_4$ and $XeF_4$.
(A) $N_2O$ (B) $H_2O$ (C) $SF_6$ (D) Xe

31. The number of stereoisomers for complex $Ma_2b_2c_2$ (a, b and c are monodentate ligands).
(A) 6 (B) 5 (C) 4 (D) 3

32. What is the compound does not satisfy the 18-e rule.
(A) Pt(ethylenediamine)$_2Cl_2$ (B) $(\eta^6\text{-}C_6H_6)Fe(CO)_2$ (C) $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ (D) $Rh(PPh_3)_3Cl$

33. What is the number of CO stretching vibrations in *fac*-$Cr(CO)_3(CH_3CN)_3$.
(A) 4 (B) 3 (C) 2 (D) 1

34. Transition-metal atoms have five *d* orbitals in addition to one *s* and three *p* orbitals in their valence shells. Each transition-metal atom achieves special stability when its electron configuration has 18 valence electrons. Using the 18-electron rule, which of the following transition-metal complexes does not follow this rule?
(A) $PtCl_4^{2-}$, (B) $Cr(CO)_6$, (C) $Mn_2(CO)_{10}$, (D) $Ni(CN)_5^{3-}$.

35. Using the VSEPR model of molecular shape, which of the following molecules does not adopt

the trigonal planar molecular shape?

(A) $SO_3$, (B) $NO_3^-$, (C) $NH_3$, (D) $BF_3$.

36. A chiral complex is a complex that is not superimposable on its own mirror image. Which of the following complexes is achiral?

(A) *cis*-$[CoCl_2(en)_2]$, (B) $[Cr(edta)]^-$, (C) *trans*-$[CrCl_2(ox)_2]^{3-}$, (D) $[Ru(bipy)_3]^{2+}$.

37. Crystals of ZnS exhibit two types of packing order (zinc blende and wurtzite). The respective coordination numbers for zinc atom and sulfur atom in the crystal structure are:

(A) 4 and 8, (B) 6 and 3, (C) 6 and 6, (D) 4 and 4.

38. Which of the following complex ions is expected to show pale color due to weak forbidden transitions?

(A) $Cu(NH_3)_4^{2+}$, (B) $Mn(H_2O)_6^{2+}$, (C) $CrF_6^{3-}$, (D) $Co(en)_3^{2+}$.

39. Which of the following correctly lists the conformations of cyclohexane in order of increasing energy?

(A) chair < boat < twist < half-chair

(B) half-chair < boat < twist < chair

(C) chair < twist < half-chair < boat

(D) chair < twist < boat < half-chair

40. When ionization occurs at the single stereocenter of a chiral compound, the resulting carbocation is:

(A) chiral (B) achiral (C) racemic (D) optically active

41. What results when *cis*-2-butene is subjected to the following reaction sequence: (1) $Cl_2$, $H_2O$, (2) NaOH, (3) $H_3O^+$?

(A) a meso epoxide (B) a 1:1 mixture of enantiomeric epoxides

(C) a meso diol (D) a 1:1 mixture of enantiomeric diols

42. When 1,2-dibromobutane is heated at 200°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

43. The Diels-Alder reaction is a concerted reaction; this means:

(A) a mixture of endo and exo products are formed.

(B) all bond making and bond breaking occurs simultaneously.

(C) the products contain rings.

(D) the reaction follows Markovnikov's rule.

44. Which of the following undergoes $S_N2$ reaction with sodium methoxide most rapidly?

(A) $PhCH_2Br$ (B) $Ph_3CBr$ (C) $PhCH_2CH_2Br$ (D) PhBr

45. 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

46. What intermediate occurs when a ketone undergoes a Wolff-Kishner reduction?
(A) a hydrazone (B) a hydrated aldehyde (C) a carboxylate (D) an amalgam

47. Secondary amines react with the nitrosonium ion to generate:
(A) diazonium salts (B) N-nitrosoamines (C) oximes (D) imines

48. The Cannizzaro reaction results in:
(A) an intramolecular hydride transfer. (B) an intermolecular hydride transfer.
(C) an intramolecular methyl shift. (D) an intermolecular methyl transfer.

49. What two atomic orbitals or hybrid atomic orbitals overlap to form the C-C $\sigma$ bond in ethylene?
(A) C $sp^3$ + C $sp^3$ (B) C $sp^3$ + C $sp^2$ (C) C $sp^2$ + C $sp^2$
(D) C $sp^3$ + C p

50. A mixture of equal amounts of two enantiomers _____.
(A) is called a racemic mixture (B) is optically inactive
(C) implies that the enantiomers are meso forms (D) both a and b