

單選 50 題 (每題二分，共 100 分)答錯不倒扣

- Which one of the following is the strongest intermolecular force experienced by noble gases?
(A) polar covalent bonds (B) hydrogen bonding (C) London dispersion forces (D) ionic bonding (E) dipole-dipole interactions
- The sodium salt, NaA, of a weak acid is dissolved in water; no other substance is added. Which of these statements (to a close approximation) is true?
(A) $[H^+] = [A^-]$ (B) $[A^-] = [OH^-]$ (C) $[HA] = [OH^-]$ (D) $[H^+] = [OH^-]$ (E) none of these
- Calculate the pH of 0.10 M NH_4CN . (K_b for $NH_3 = 1.8 \times 10^{-5}$; K_a for $HCN = 6.2 \times 10^{-10}$)
(A) 5.79 (B) 8.21 (C) 8.87 (D) 5.13 (E) 9.23
- Compounds X and Y have the same mass, but compound Y has two more atoms in its structure. Which statements must be true?
(A) C_v for compound X is greater than C_v for Y (B) C_v for compound X is less than C_v for Y (C) C_p for compound X is greater than C_p for Y (D) C_p for compound X is less than C_p for Y (E) B and D
- Which of the following gases is/are present in the fuel obtained after coal gasification?
I: octene gas; II: synthetic gas; III: methane gas; IV: mercaptan gas; V propane gas
(A) I and IV (B) I and V (C) I, II and III (D) III, IV, and V (E) II and III
- When the equation for the following reaction in basic solution is balanced, what is the sum of the coefficients?
 $MnO_4^-(aq) + CN^-(aq) \rightarrow MnO_2(s) + CNO^-(aq)$
(A) 20 (B) 10 (C) 8 (D) 13 (E) 11
- A solution contains the ions Ag^+ , Pb^{2+} , and Ni^{2+} . Dilute solutions of NaCl, Na_2SO_4 , and Na_2S are available to separate the positive ions from each other. In order to effect separation, the solutions should be added in which order?
(A) Na_2S , NaCl, Na_2SO_4 (B) Na_2SO_4 , NaCl, Na_2S (C) Na_2SO_4 , Na_2S , NaCl (D) NaCl, Na_2S , Na_2SO_4 (E) NaCl, Na_2SO_4 , Na_2S
- When $NH_3(aq)$ is added to $Cu^{2+}(aq)$, a precipitate initially forms. What is its formula?
(A) CuO (B) $Cu(NH_3)$ (C) $Cu(OH)_2$ (D) $Cu(NO_3)_2$ (E) $Cu(NH_3)_2^{2+}$
- Order the following according to increasing rate of effusion:
(A) $CH_4 < NO_2 < NO < F_2 < Cl_2$ (B) $Cl_2 < F_2 < NO_2 < CH_4 < NO$ (C) $Cl_2 < NO_2 < F_2 < NO < CH_4$ (D) $CH_4 < NO < F_2 < NO_2 < Cl_2$ (E) $F_2 < NO < Cl_2 < NO_2 < CH_4$
- As water is heated, its pH decreases. This means that
(A) $[OH^-] > [H^+]$ (B) $[H^+] > [OH^-]$ (C) the water is no longer neutral (D) two of these are correct. (E) none of these is correct.
- A 100.0-mL sample of 0.2 M $(CH_3)_3N$ ($K_b = 5.3 \times 10^{-5}$) is titrated with 0.2 M HCl. What is the pH at the equivalence point?
(A) 5.4 (B) 7.0 (C) 10.3 (D) 3.1 (E) 9.9
- You have a solution of 0.10 M Cl^- and 0.10 M CrO_4^{2-} . You add 0.10 M silver nitrate dropwise into the solution. K_{sp} for Ag_2CrO_4 is 9.0×10^{-12} and for $AgCl$ is 1.6×10^{-10} . Which of the following will precipitate first?
(A) silver nitrate (B) silver chromate (C) cannot be determined from the information given (D) silver chloride (E) none of these

13. A 0.012-mol sample of Na_2SO_4 is added to 400 mL of each of two solutions. One solution contains $1.5 \times 10^{-3} \text{ M}$ BaCl_2 ; the other contains $1.5 \times 10^{-3} \text{ M}$ CaCl_2 . K_{sp} for $\text{BaSO}_4 = 1.5 \times 10^{-9}$ and K_{sp} for $\text{CaSO}_4 = 6.1 \times 10^{-5}$. Which of the following statements is true?
 (A) both BaSO_4 and CaSO_4 would precipitate (B) not enough information is given to determine whether precipitation would occur (C) CaSO_4 would precipitate, but BaSO_4 would not (D) BaSO_4 would precipitate but CaSO_4 would not (E) neither BaSO_4 nor CaSO_4 would precipitate.
14. ΔS_{surr} is _____ for exothermic reactions and _____ for endothermic reactions.
 (A) favorable, unfavorable (B) favorable, favorable (C) unfavorable, favorable (D) unfavorable, unfavorable (E) cannot tell
15. For the reaction $\text{A} + \text{B} \rightarrow \text{C} + \text{D}$, $\Delta H^\circ = +40 \text{ kJ}$ and $\Delta S^\circ = +50 \text{ J/K}$. Therefore, the reaction under standard conditions is
 (A) spontaneous only at temperatures between 10 K and 800 K (B) spontaneous at temperatures greater than 800 K (C) spontaneous at all temperatures (D) nonspontaneous at all temperatures (E) spontaneous at temperatures less than 10 K
16. When a battery dies, which of the following is true?
 (A) $\Delta G^\circ = 0$ (B) $\Delta G = 0$ (C) $E^\circ = 0$ (D) $Q = 1$ (E) A and C
17. Which of the following statements is/are true of the electrolysis of brine?
 I: chlorine is produced at the anode of the cell during the electrolysis of brine; II: under normal circumstances, sodium is produced at the cathode of the cell during the electrolysis of brine; III: hydrogen is produced at the cathode of the cell during the electrolysis of brine.
 (A) I only (B) II only (C) III only (D) I and II (E) I and III
18. How many f orbitals have the value $n = 3$?
 (A) 3 (B) 1 (C) 0 (D) 5 (E) 7
19. How many unpaired electrons does cobalt have in its ground state?
 (A) 7 (B) 27 (C) 5 (D) 3 (E) 1
20. Which of the following exhibits the correct orders (increasing) for atomic radius and ionization energy, respectively?
 (A) F, S, O, and O, S, F (B) F, O, S, and S, O, F (C) S, O, F, and F, O, S (D) S, F, O, and S, F, O (E) none of these
21. Draw the Lewis structures of the molecules below, and use them to answer the following questions. How many of the molecules have no dipole moment?
 BH_3 , NO_2 , SF_6 , O_3 and PCl_5
 (A) 2 (B) 4 (C) 1 (D) 3 (E) they are all polar.
22. How many of the following molecules and ions are linear?
 NCl_3 , CH_4 , SCN^- , CS_2 and NO_2^-
 (A) 4 (B) 2 (C) 3 (D) 1 (E) 0
23. How many of the following molecules have all of their atoms in the same plane?
 $\text{H}_2\text{C} = \text{CH}_2$, F_2O , H_2CO , NH_3 , CO_2 , BeCl_2 and H_2O_2
 (A) 4 (B) 5 (C) 6 (D) 7 (E) 3
24. Which of the following statements about the CO_3^{2-} ion is *false*?
 (A) the ion has a total of 24 electrons (B) the orbitals on the carbon atom are sp^2 hybridized (C) the ion is expected to be diamagnetic (D) one C–O bond is shorter than the others (E) it has a planar molecular geometry

25. An ethyl group (CH_3CH_2^-) that is attached to a substituent that does not contain a hydrogen atom appears as what in a NMR spectrum?
(A) a triplet and a quartet with relative intensities of 3 and 2, respectively (B) a triplet and a quartet with relative intensities of 2 and 3, respectively (C) a doublet and a triplet with relative intensities of 2 and 3, respectively (D) a doublet and a triplet with relative intensities of 3 and 2, respectively (E) none of these
26. How many of the following has a bond order = 0.5?
 H_2 , H_2^+ , H_2^- , CN^- , CN , CN^+
(A) 2 (B) 3 (C) 4 (D) 1 (E) 0
27. In the unit cell of sphalerite, Zn^{2+} ions occupy half the tetrahedral holes in a face-centered cubic lattice of S^{2-} ions. What is the number of formula units of ZnS in the unit cell?
(A) 3 (B) 5 (C) 4 (D) 1 (E) 2
28. Which of the compounds below is an example of a network solid?
(A) $\text{NaCl}(s)$ (B) $\text{S}_8(s)$ (C) $\text{MgO}(s)$ (D) $\text{SiO}_2(s)$ (E) $\text{C}_{25}\text{H}_{52}(s)$
29. A certain substance, X, has a triple-point temperature of 20°C at a pressure of 2.0 atm. Which one of the following statements cannot possibly be true?
(A) X can exist as a liquid above 20°C (B) both liquid and solid X have the same vapor pressure at 20°C (C) liquid X can exist as a stable phase at 25°C , 1 atm (D) X can exist as a solid above 20°C (E) all of these statements could be true
30. The density of the solid phase of a substance is 0.90 g/cm^3 and the density of the liquid phase is 1.0 g/cm^3 . A large increase in pressure will
(A) lower the freezing point (B) lower the boiling point (C) lower the triple point (D) raise the triple point (E) raise the freezing point.
31. Which of the following is the most polarizable?
(A) Ar (B) He (C) Kr (D) Ne (E) Xe
32. For which of the following compound(s) are *cis* and *trans* isomers possible?
(A) difluoroethyne (B) 2,3-dichloro-2-butene (C) 3,4-diethyl-3-hexene (D) ortho-chloroaniline (E) 4,4-dimethylcyclohexanol
33. Aspirin is formed via a(n) _____ reaction.
(A) combustion (B) hydrogenation (C) condensation (D) substitution (E) addition
34. Which of the following is optically active?
(A) 3-chloropentane (B) 1-bromopentane (C) 2-chloropentane (D) dichloromethane (E) dimethylamine
35. Choose the correct molecular structure for XeF_6 .
(A) trigonal planar (B) octahedral (C) trigonal bipyramidal (D) tetrahedral (E) none of these
36. The deciding factor that makes HF a weak acid is that
(A) HF has a large bond energy (B) F_2 has a small bond energy (C) the entropy for hydration of F^- is a large negative value (D) the enthalpy of hydration of F^- is negative (E) F^- has the largest ionization energy of all the halide ions

37. How many of the following statements are *false*?

I: the Group 3A elements are all metals; II: Alkaline earth metals react less vigorously with water than do alkali metals; III: Salts can consist of hydrogen; IV: because Li is the strongest reducing agent among the alkali metals, it reacts most; V: quickly with water of the alkali metals

(A) 1 (B) 3 (C) 2 (D) 4 (E) 0

38. The solubility of the salt M_xA_y is 1.0×10^{-2} mol/L at 25°C . The osmotic pressure exhibited by a solution saturated with M_xA_y at 25°C is 1.22 atm. Determine the values of x and y by assuming ideal behavior.

(A) $x = 1, y = 3$ (B) $x = 2, y = 5$ (C) $x = 1, y = 1$ (D) $x = 2, y = 3$ (E) none of these

39. A cucumber is placed in a concentrated salt solution. What is most likely to happen?

(A) salt will precipitate out (B) water will flow from the solution to the cucumber (C) salt will flow into the cucumber (D) water will flow from the cucumber to the solution (E) no change will occur

40. Liquid A has vapor pressure x . Liquid B has vapor pressure y , and $x > y$. What is the mole fraction of A in the liquid mixture if the vapor above the solution is 50% A?

(A) $y/(2x + 2y)$ (B) $y/(x + y)$ (C) $x/(2x + 2y)$ (D) $x/(x + y)$ (E) none of these

41. Rank the following compounds according to increasing solubility in water.

I: $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_3$; II: $\text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3$; III: $\text{CH}_3\text{-CH}_2\text{-OH}$; IV: $\text{CH}_3\text{-OH}$

(A) $\text{I} < \text{II} < \text{IV} < \text{III}$ (B) $\text{I} < \text{III} < \text{IV} < \text{II}$ (C) $\text{I} < \text{II} < \text{III} < \text{IV}$ (D) $\text{III} < \text{IV} < \text{II} < \text{I}$ (E) none is correct.

42. A liquid-liquid solution is called an ideal solution if

I: it obeys $PV = nRT$; II: it obeys Raoult's law; III: solute-solute, solvent-solvent, and solute-solvent interactions are very similar; IV: solute-solute, solvent-solvent, and solute-solvent interactions are quite different.

(A) II, IV (B) II, III (C) I, II (D) I, II, III (E) I, II, IV

43. How many unpaired electrons are found in NiBr_4^{2-} ?

(A) 0 (B) 4 (C) 1 (D) 5 (E) 2

44. Which of the following statements about the complex ion $\text{Co(en)}_2\text{Cl}_2^+$ ($\text{en} = \text{ethylenediamine}, \text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$) is true?

(A) the geometric isomers of the complex ion have identical chemical properties (B) the complex ion exhibits two geometric isomers (*cis* and *trans*) and two optical isomers (C) because en is a strong field ligand (large Δ), the complex ion is paramagnetic (D) the complex ion exhibits *cis* and *trans* geometric isomers, but no optical isomers (E) the complex ion contains Co(I)

45. The spectrochemical series is $\text{I}^- < \text{Br}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^-$

Which of the following complexes will absorb visible radiation of the highest energy?

(A) $[\text{Co}(\text{OH})_6]^{3-}$ (B) $[\text{Co}(\text{NH}_3)_6]^{3+}$ (C) $[\text{Co}(\text{I})_6]^{3-}$ (D) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ (E) $[\text{Co}(\text{en})_3]^{3+}$

46. Which of the following complexes would be diamagnetic?

(A) $[\text{Fe}(\text{CN})_6]^{4-}$ (B) $[\text{Mn}(\text{CN})_6]^{4-}$ (C) $[\text{V}(\text{CN})_6]^{3-}$ (D) $[\text{Cr}(\text{CN})_6]^{3-}$ (E) $\text{Fe}(\text{CO})_5$

47. Which has the greater number of unpaired electrons?

I: square planar $\text{Ni}(\text{CN})_4^{2-}$; II: tetrahedral FeCl_4^-

(A) I (B) II (C) neither I nor II has any unpaired electrons (D) more information is needed (E) both I and II have the same (nonzero) number of unpaired electrons

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48. When heat is added to proteins, the hydrogen bonding in the secondary structure breaks apart. What are the algebraic signs of ΔH and ΔS for the denaturation process?

(A) ΔH is negative and ΔS is positive (B) both ΔH and ΔS are negative (C) ΔH is positive and ΔS is 0 (D) both ΔH and ΔS are positive (E) ΔH is positive and ΔS is negative

49. Which of the following polymers is *not* based on a substituted ethylene monomer?

(A) polystyrene (B) Teflon (C) nylon (D) polyvinylchloride (E) polypropylene

50. Which of the following statements is/are true of alcohols?

I: alcohols are characterized by the presence of the hydroxyl group (-OH); II: the systematic name for an alcohol is obtained by replacing the final -e of the parent hydrocarbon with -oxyl; III: alcohols usually have much lower boiling points than might be expected from their molar masses.

(A) III only (B) II only (C) I only (D) I and III (E) I and 2