＊選擇題請在答案卡內作答

單選 50 題,共 100 分/每題二分 (答錯不倒扣)

1. For the reaction $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g)$, what is the relationship between K and K_p at temperature T?
(A) $K = K_p$ (B) $K = K_p(RT)^2$ (C) $K_p = K(RT)^2$ (D) $K = K_p(RT)$ (E) $K_p = K(RT)$

2. For a particular system at a particular temperature, there are ＿＿＿＿ equilibrium constant(s) and ＿＿＿＿＿ equilibrium position(s).
(A) an infinite number of, one (B) one, an infinite number of (C) one, one (D) an infinite number of, an infinite number of (E) none of these

3. Force per impact versus the molar mass of the ideal gas. Which graph represents the plot?

(A)　　　　　(B)　　　　　(C)　　　　　(D)　　　　　(E) none of these

4. Which of the following statements is true concerning ideal gases?
(A) the temperature of the gas sample is directly related to the average velocity of the gas particles (B) at STP, 1.0 L of Ar(g) contains about twice the number of atoms as 1.0 L of Ne(g) because the molar mass of Ar is about twice that of Ne (C) a gas exerts pressure as a result of the collisions of the gas molecules with the walls of the container (D) the gas particles in a sample exert attraction on one another (E) all of these statements are false

5. When the equation $Cl_2 \rightarrow Cl^- + ClO_3^-$ (basic solution) is balanced using the smallest whole-number coefficients, what is the coefficient of OH^-?
(A) 1 (B) 2 (C) 3 (D) 4 (E) 6

6. For the reaction of sodium bromide with chlorine gas to form sodium chloride and bromine, what are the appropriate half-reactions? (ox = oxidation and re = reduction)
(A) ox: $Cl_2 + 2e^- \rightarrow 2Cl^-$;　　re: $2Br^- \rightarrow Br_2 + 2e^-$
(B) ox: $2Br^- \rightarrow Br_2 + 2e^-$;　　re: $Cl_2 + 2e^- \rightarrow 2Cl^-$
(C) ox: $Cl + e^- \rightarrow Cl^-$;　　re: $Br \rightarrow Br^- + e^-$
(D) ox: $Br + 2e^- \rightarrow Br^{2-}$;　　re: $2Cl^- \rightarrow Cl_2 + 2e^-$
(E) ox: $2Na^+ + 2e^- \rightarrow 2Na$;　　re: $2Cl^- \rightarrow Cl_2 + 2e^-$

7. 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_2SO_4, $NaCl$, Na_2S (B) Na_2SO_4, Na_2S, $NaCl$ (C) Na_2S, $NaCl$, Na_2SO_4 (D) $NaCl$, Na_2S, Na_2SO_4 (E) $NaCl$, Na_2SO_4, Na_2S

8. 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) $[H^+] = [OH^-]$ (C) $[A^-] = [OH^-]$ (D) $[HA] = [OH^-]$ (E) none of these

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9. Consider two separate solutions of equal concentration. The first solution contains sodium hydroxide, and the second solution contains barium hydroxide. Which solution has the lower pH? (A) the sodium hydroxide solution (B) the barium hydroxide solution (C) the pH's of the two solutions are equal (D) we need to know the concentrations to answer this questio (E) we need to know the volumes to answer this question

10. Identify the strongest base.
(A) CH_3O^- (B) CH_3OH (C) CN^- (D) H_2O (E) NO_3^-

11. Which statement is true of a process in which 1 mol of a gas is expanded from state A to state B? (A) when the gas expands from state A to state B, the surroundings are doing work on the system (B) the amount of work done in the process must be the same, regardless of the path (C) it is not possible to have more than one path for a change of state (D) the final volume of the gas will depend on the path taken (E) the amount of heat released in the process will depend on the path taken

12. Which of the following statements is correct?
(A) the internal energy of a system increases when more work is done by the system than heat is flowing into the system (B) the internal energy of a system decreases when work is done on the system and heat is flowing into the system (C) the system does work on the surroundings when an ideal gas expands against a constant external pressure (D) all the statements are true (E) all the statements are false

13. For the vaporization of a liquid at a given pressure,
(A) ΔG is positive at all temperatures (B) ΔG is negative at all temperatures (C) ΔG is positive at low temperatures but negative at high temperatures (and zero at some temperature) (D) ΔG is negative at low temperatures but positive at high temperatures (and zero at some temperature) (E) none of above

14. ΔS_{surr} is ___ for exothermic reactions and ___ for endothermic reactions.
(A) favorable, unfavorable (B) unfavorable, favorable (C) favorable, favorable (D) unfavorable, unfavorable (E) cannot tell

15. From the following list of observations, choose the one that most clearly supports the conclusion that the mass of the atom is located mainly in the nucleus.
(A) the emission spectrum of hydrogen (B) the photoelectric effect (C) the scattering of alpha particles by metal foil (D) diffraction (E) cathode "rays"

16. Which of the following is a reasonable criticism of the Bohr model of the atom?
(A) it makes no attempt to explain why the negative electron does not eventually fall into the positive nucleus (B) it does not adequately predict the line spectrum of hydrogen (C) it does not adequately predict the ionization energy of the valence electron(s) for elements other than hydrogen (D) it does not adequately predict the ionization energy of the first-energy-level electrons for elements other than hydrogen (E) it shows the electrons to exist outside of the nucleus

17. Which of the following is *not* determined by the principal quantum number, n, of the electron in a hydrogen atom?

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(A) the energy of the electron (B) the minimum wavelength of the light needed to remove the electron from the atom (C) the size of the corresponding atomic orbital(s) (D) the shape of the corresponding atomic orbital(s) (E) all of the above are determined by n

18. Which of the following statements is *false*?
(A) an orbital can accommodate at most two electrons (B) the electron density at a point is proportional to ψ^2 at that point (C) the spin quantum number of an electron must be either $+1/2$ or $-1/2$ (D) a 2p orbital is more penetrating than a 2s; that is, it has a higher electron density near the nucleus and inside the charge cloud of a 1s orbital (E) in the usual order of filling, the 6s orbital is filled before the 4f orbital

19. The valence electron configuration of an element is $ns^2(n-1)d^{10}np^2$. To which group does X belong?
(A) Group 3A (B) Group 4A (C) Group 5A (D) Group 6A (E) Group 7A

20. In a 0.1 molar solution of NaCl in water, which of the following will be closest to 0.1?
(A) the mole fraction of NaCl (B) the mass fraction of NaCl (C) the mass percent of NaCl (D) the molality of NaCl (E) all of these are about 0.1

21. Which statement about hydrogen bonding is true?
(A) hydrogen bonding is the intermolecular attractive forces between two hydrogen atoms in solution.
(B) the hydrogen-bonding capabilities of water molecules cause $CH_3CH_2CH_2CH_3$ to be more soluble in water than is CH_3OH (C) hydrogen bonding of solvent molecules with a solute will not affect the solubility of the solute (D) hydrogen-bonding interactions between molecules are stronger than the covalent bonds within the molecule (E) hydrogen bonding arises from the dipole moment created by the unequal sharing of electrons in certain covalent bonds within a molecule

22. A solution of two liquids, A and B, shows negative deviation from Raoult's law. This means that
(A) molecules of A interact strongly with other A-type molecules (B) the two liquids have a positive heat of solution (C) molecules of A interact weakly, if at all, with B molecules (D) the molecules of A hinder the strong interaction between B molecules (E) molecules of A interact more strongly with B than with A or and more strongly than B with B

23. Which of the following will cause the calculated molar mass of a compound determined by the freezing-point depression method to be greater than the true molar mass?
(A) water gets into the solvent after the freezing point of the pure solvent is determined (B) some of the solute molecules break apart (C) the mass of solvent is smaller than determined from the weighing (D) while adding the solute, the technician spilled some of it on the lab bench (E) all of these

24. A cucumber is placed in a concentrated salt solution. What is most likely to happen?
(A) water will flow from the cucumber to the solution (B) water will flow from the solution to the cucumber (C) salt will flow into the cucumber (D) salt will precipitate out (E) no change will occur

25. The phrase "a solid dissolved in a gas" describes a(n)
(A) foam (B) sol (C) emulsion (D) aerosol (E) none of these

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26. Select the correct molecular structure for PO_3^{3-}.
(A) pyramidal (B) tetrahedral (C) square planar (D) octahedral (E) none of these

27. Which ion is planar?
(A) PCl_4^+ (B) CO_3^{2-} (C) SO_4^{2-} (D) ClO_3^- (E) SCl_5^-

28. The bond angles about the carbon atom in the formaldehyde molecule, $H_2C = O$, are about
(A) 120° (B) 60° (C) 109° (D) 180° (E) 90°

29. How many of the following molecules and ions are linear? NF_3, NH_4^+, HCN, CO_2, NO_2^-
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

30. Consider the following molecules, and select the molecule(s) that fit the given statement.
 I: BF_3, II: $CHBr_3$, III: Br_2, IV: $XeCl_2$, V: CO, VI: SF_4
These molecules violate the octet rule.
(A) I, II, IV (B) I, III, IV, VI (C) III, V, VI (D) I, IV, VI (E) I, II, IV, VI

31. Consider the molecular-orbital description of the NO^- anion. Which of the following statements is *false*?
(A) NO^- is paramagnetic (B) NO^- is isoelectronic with CO (C) the bond energy in NO^+ is greater than the bond energy in NO^- (D) the bond order in NO^- is 2 (E) ll of these statements are false

32. For how many of B_2, C_2, P_2, and F_2 does bond order decrease if one electron is removed from the neutral molecule?
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

33. Order the following from shortest to longest bond: C_2, B_2, H_2, N_2
(A) H_2, N_2, C_2, B_2 (B) N_2, C_2, B_2, H_2 (C) C_2, N_2, H_2, B_2 (D) C_2, B_2, H_2, N_2 (E) none of these

34. Of the three cubic unit cells, which lattice packing leaves the least amount of free space in the cell?
(A) simple cubic (B) body centered cubic (C) face centered cubic (D) need cell dimensions to determine this (E) hexagonal

35. A liquid placed in a closed container will evaporate until equilibrium is reached. At equilibrium, which of the following statements is *not* true?
(A) the partial pressure exerted by the vapor molecules is called the vapor pressure of the liquid (B) liquid molecules are still evaporating (C) the number of vapor molecules remains essentially constant (D) the boundary (meniscus) between the liquid and the vapor disappears (E) all of these statements are true

36. A *p*-type semiconductor
(A) is made by doping host atoms with atoms having more valence electrons than the host (B) is made by doping host atoms with atoms having fewer valence electrons than the host (C) has electrons that lie close in energy to the conduction bands (D) two of these (E) none of these

37. 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?

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(A) 5 (B) 4 (C) 3 (D) 2 (E) 1

38. Specify the number of unpaired electrons in CoF_6^{3-}.
(A) 0 (B) 1 (C) 2 (D) 4 (E) 5

39. Which of the following complexes would be diamagnetic?
(A) $Mn(CN)_6]^{4-}$ (B) $V(CN)_6]^{3-}$ (C) $Co(CN)_6]^{3-}$ (D) $[Cr(CN)_6]^{3-}$ (E) none of these

40. For the process $Co(NH_3)_5Cl^{2+} + Cl^- \rightarrow Co(NH_3)_4Cl_2^+ + NH_3$, what would be the ratio of *cis* to *trans* isomers in the product?
(A) 1:1 (B) 1:2 (C) 1:4 (D) 4:1 (E) 2:1

41. ___ isomers and ___ isomers are classes of structural isomers.
(A) Geometric, optical (B) Coordination, geometric (C) Linkage, geometric (D) Coordination, linkage (E) Geometric, linkage

42. How many of the following molecules exist?
 I: methane, II: cycloethane, III: isopropyne, IV: neobutane
(A) 0 (B) 4 (C) 2 (D) 1 (E) 3

43. The overall shape of a protein is maintained by
(A) hydrogen bonding (B) ionic bonds (C) dipole-dipole bonding (D) covalent bonds (E) all of these

44. What are the building blocks of proteins?
(A) nucleotides (B) glucose and sucrose (C) lipids (D) amino acids (E) azide

45. Which factor is *not* characteristic of a strong polymer?
(A) high crystallinity (B) branching (C) strong intermolecular forces (D) high molecular weight (E) isotactic

46. Starch is best described as a
(A) lipid (B) simple sugar (C) amino acid (D) polysaccharide (E) peptide

47. Nitrogen fixation
(A) is used to manufacture ammonia (B) transforms nitrogen to other nitrogen-containing compounds (C) is used to recover sulfur from underground deposits (D) is used to produce nitric acid (E) none of these

48. Which of the following is the most abundant metal on earth?
(A) calcium (B) iron (C) copper (D) aluminum (E) zinc

49. Choose the element that is the strongest reducing agent in the gas phase.
(A) Li (B) Na (C) K (D) Rb (E) Cs

50. Which group contains two elements that exhibit +2 and +4 oxidation states?
(A) Group 1A (B) Group 3A (C) Group 4A (D) Group 5A (E) Group 7A