

單選題：(1-30 題每題 2 分，31-40 題每題 4 分，共 100 分；答錯或不答不給分亦不扣分)

1. What element (in trace amounts) has been shown to help in protecting against heart disease and cancer?
(A) silicon (B) oxygen (C) selenium (D) copper (E) potassium
2. The interaction between solute particles and water molecules, which tends to cause a salt to fall apart in water, is called (A) hydration. (B) polarization. (C) dispersion. (D) coagulation. (E) conductivity.
3. Use the ideal gas law to predict the relationship between n and T if pressure and volume are held constant.
(A) $n \propto T$ (B) $n \propto 1/T$ (C) $n/T = \text{constant}$ (D) $PT = nRV$ (E) $PV/T = R$
4. It is found that 250. mL of gas at STP has a mass of 1.00 g. What is the molar mass?
(A) 89.6 g/mol (B) 28.0 g/mol (C) 14.0 g/mol (D) 22.4 g/mol (E) 98.0 g/mol
5. Which of the following is true?
(A) When a gas is compressed, w is negative. (B) Temperature is an extensive property.
(C) Hess's law is a notable exception to the first law of thermodynamics.
(D) The melting of ice is an exothermic process.
(E) The change in enthalpy is the same as heat at constant pressure.
6. For a particular process $q = -17 \text{ kJ}$ and $w = 21 \text{ kJ}$. Which of the following statements is false?
(A) Heat flows from the system to the surroundings. (B) The system does work on the surroundings.
(C) $E = +4 \text{ kJ}$ (D) The process is exothermic. (E) None of these is false.
7. Which of the following statements is true?
(A) The exact location of an electron can be determined if we know its energy.
(B) An electron in a 2s orbital can have the same n , l , and m_l quantum numbers as an electron in a 3s orbital.
(C) Ni has 2 unpaired electrons in its 3d orbitals.
(D) In the buildup of atoms, electrons occupy the 4f orbitals before the 6s orbitals.
(E) Only three quantum numbers are needed to uniquely describe an electron.
8. Which of the following pairs is isoelectronic?
(A) Li^+ and K^+ (B) Na^+ and Ne (C) I^- and Cl^- (D) S^{2-} and Ne (E) Al^{3+} and B^{3+}
9. Which ion is planar?
(A) NH_4^+ (B) CO_3^{2-} (C) SO_3^{2-} (D) ClO_3^- (E) all are planar
10. Which of the following substances contains two pi bonds?
(A) C_2H_4 (B) C_3H_8 (C) C_2H_2 (D) C_2H_6 (E) CH_4
11. The fact that O_2 is paramagnetic can be explained by
(A) the Lewis structure of O_2 . (B) resonance. (C) a violation of the octet rule.
(D) the molecular orbital diagram for O_2 . (E) hybridization of atomic orbitals in O_2 .
12. Solid MgO has the same crystal structure as NaCl. How many oxide ions surround each Mg^{2+} ion as nearest neighbors in MgO?
(A) 4 (B) 6 (C) 8 (D) 10 (E) 12
13. The triple point of iodine is at 90 torr and 115°C . This means that liquid I_2
(A) is more dense than $\text{I}_2(\text{s})$. (B) cannot exist above 115°C (C) cannot exist at 1 atmosphere pressure.
(D) cannot have a vapor pressure less than 90 torr. (E) can exist at pressure of 10 torr.

(背面仍有題目，請繼續作答)

14. Which of the following concentration measures will change in value as the temperature of a solution changes?
 (A) mass percent (B) mole fraction (C) molality (D) molarity (E) all of these
15. A solution of two liquids, A and B, shows negative deviation from Raoult's law. This means that
 (A) the 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 A with A or B with B.
16. Consider the following rate law: $\text{Rate} = k[\text{A}]^n[\text{B}]^m$; How are the exponents n and m determined?
 (A) By using the balanced chemical equation (B) By using the subscripts for the chemical formulas
 (C) By using the coefficients of the chemical formulas (D) By educated guess (E) By experiment
17. What are the proper units for the rate constant for the second order of an overall reaction?
 (A) s^{-1} (B) $\text{mol L}^{-1} \text{s}^{-1}$ (C) $\text{L mol}^{-1} \text{s}^{-1}$ (D) $\text{L}^3 \text{mol}^{-3} \text{s}^{-1}$ (E) $\text{L}^2 \text{mol}^{-2} \text{s}^{-1}$
18. Which of the following is true for a system whose equilibrium constant is relatively small?
 (A) It will take a short time to reach equilibrium. (B) It will take a long time to reach equilibrium.
 (C) The equilibrium lies to the left. (D) The equilibrium lies to the right. (E) Two of these.
19. At 0°C , the ion-product constant of water, K_w , is 1.2×10^{-15} . The pH of pure water at 0°C is:
 (A) 7.00 (B) 6.88 (C) 7.56 (D) 7.46 (E) 6.64
20. The correct mathematical expression for finding the molar solubility (S) of $\text{Sn}(\text{OH})_2$ is:
 (A) $2S^2 = K_{sp}$ (B) $2S^3 = K_{sp}$ (C) $108S^5 = K_{sp}$ (D) $4S^3 = K_{sp}$ (E) $8S^3 = K_{sp}$
21. Which of the following is the best reducing agent?
 (A) Cl_2 (B) H_2 (C) Mg (D) Mg^{2+} (E) Cl^-
22. Choose the solid that has the smallest ionization energy.
 (A) $\text{Be}(\text{s})$ (B) $\text{Mg}(\text{s})$ (C) $\text{Ca}(\text{s})$ (D) $\text{Sr}(\text{s})$ (E) $\text{Ba}(\text{s})$
23. With which of the following elements does silicon form the strongest bonds?
 (A) Si (B) C (C) H (D) O (E) B
24. Phosphorus is found in nature
 (A) as white phosphorus. (B) as red phosphorus. (C) as black phosphorus.
 (D) usually as the PO_4^{3-} ion in phosphate rock. (E) in gypsum.
25. All of the following statements about helium are true except
 (A) it forms no compounds. (B) it is used as a coolant. (C) it is a component of the sun.
 (D) it is used in luminescent lighting. (E) the major sources on earth are natural gas deposits.
26. Which of the following is true in describing the crystal field model?
 (A) The metal ion and ligand interaction is treated as a Lewis acid-base interaction.
 (B) The ligands are treated as negative point charges.
 (C) The metal ion-ligand bonds are considered to be completely ionic.
 (D) The electrons are assumed to be localized.
 (E) None of these is true.
27. Which of the following are structural isomers?
 I. coordination isomers II. linkage isomers III. geometric isomers IV. optical isomers
 (A) I, III (B) II, IV (C) I, III, IV (D) II, III (E) I, II

28. The nuclide ${}^{12}_7\text{N}$ is unstable. What type of radioactive decay would be expected?
 (A) (${}^0_{-1}\beta^-$) (B) (${}^0_{+1}\beta^+$) (C) (${}^1_1\text{P}$) (D) (${}^4_2\text{He}^{2+}$) (E) (${}^1_0\text{n}$)
29. When ${}^{28}_{13}\text{Al}$ emits a β particle it becomes:
 (A) ${}^{27}_{12}\text{Mg}$ (B) ${}^{28}_{14}\text{Si}$ (C) ${}^{29}_{14}\text{Si}$ (D) ${}^{27}_{13}\text{Al}$ (E) ${}^{29}_{12}\text{Mg}$
30. $\text{H}_2\text{CCHCH}_2\text{N}(\text{CH}_3)_2$ is
 (A) an alkyne and a secondary amine. (B) an alkene and a primary amine.
 (C) an alkene and a tertiary amine. (D) an alkyne and a tertiary amine. (E) none of these
31. You take an aspirin tablet (a compound consisting solely of carbon, hydrogen, and oxygen) with a mass of 1.00 g burn it in air, and collect 2.20 g of carbon dioxide and 0.400 g water. The molar mass of aspirin is between 170 and 190 g/mol. The molecular form of aspirin is
 (A) $\text{C}_6\text{H}_8\text{O}_5$ (B) $\text{C}_9\text{H}_8\text{O}_4$ (C) $\text{C}_8\text{H}_{10}\text{O}_5$ (D) $\text{C}_{10}\text{H}_6\text{O}_4$ (E) $\text{C}_7\text{H}_8\text{O}_6$
32. What mass of NaOH is required to react exactly with 25.0 mL of 1.2 M H_2SO_4 ?
 (A) 1.2 g (B) 1.8 g (C) 2.4 g (D) 3.5 g (E) 2.0 g
33. Which statements about hydrogen are true?
 I. H has a lower ionization energy than He. II. H^- is smaller than H.
 III. H bonds with the halogens to form polar covalent compounds.
 IV. H is always a metal. V. H does not have a second ionization energy.
 (A) I, V (B) II, IV (C) I, III, V (D) II, IV, V (E) I, III, IV, V
34. The following reaction is investigated (assume an ideal gas mixture) : $2\text{N}_2\text{O}(\text{g}) + \text{N}_2\text{H}_4(\text{g}) \rightleftharpoons 3\text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
 Initially there are 0.10 moles of N_2O and 0.25 moles of N_2H_4 , in a 10.0-L container. If there are 0.06 moles of N_2O at equilibrium, how many moles of N_2 are present at equilibrium
 (A) 0.9 (B) 0.04 (C) 0.06 (D) 0.02 (E) 0.05
- (The K_b for $\text{NH}_3 = 1.8 \times 10^{-5}$)
 (A) 3.33 (B) 4.89 (C) 9.11 (D) 7.00 (E) 11.67
36. What is the pH of a solution that results when 0.010 mol HNO_3 is added to 500. mL of a solution that is 0.10 M in aqueous ammonia and 0.20 M in ammonium nitrate. Assume no volume change
 (A) 8.00 (B) 8.95 (C) 5.05 (D) 8.82 (E) 2.00
37. Given that ΔH_{vap} is 45.7 kJ/mol, and boiling point is 72.5°C, 1 atm, if one mole of this substance is vaporized at 1 atm, the ΔS_{sur} is
 (A) 132 J/K·mol (B) -132 J/K·mol (C) 630 J/K·mol (D) -630 J/K·mol (E) 0
38. Determine ΔG° for the following reaction: $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- | Substance | $\text{CH}_4(\text{g})$ | $\text{O}_2(\text{g})$ | $\text{CO}_2(\text{g})$ | $\text{H}_2\text{O}(\text{l})$ |
|-----------------------------|-------------------------|------------------------|-------------------------|--------------------------------|
| ΔG°_f (kJ/mol) | -50.7 | 0 | -394.4 | -237.4 |
- (A) 207.7 kJ (B) 106.3 kJ (C) 817.9 kJ (D) 130.4 kJ (E) 943.1 kJ
39. A concentration cell is constructed using two Ni electrodes with Ni^{2+} concentrations of 1.0 M and $1.00 \times 10^{-4}\text{M}$ in the two half-cells. The reduction potential of Ni^{2+} is -0.23 V. Calculate the potential of the cell at 25°C.
 (A) -0.368 V (B) +0.132 V (C) -0.132 V (D) +0.118 V (E) +0.0592 V
40. Which of the following names is a correct one?
 (A) 3,4-dichloropentane (B) cis-1,3-dimethylpropane (C) 1,1-dimethyl-2,2-diethylbutane
 (D) 1-chloro-2,4-dimethyl-3-ethylcyclohexane (E) 2-bromo-1-chloro-4,4-diethyloctane