

一、單選題（每題三分共七十二分，答錯不倒扣），請將題號及答案填寫在答案卷上

- Which of the following is a p-type semiconductor?
(A) silicon doped with arsenic (B) GaAs with arsenic in excess of gallium
(C) silicon doped with phosphorus (D) germanium doped with arsenic
(E) selenium doped with indium
- Copper and silver are malleable because they have
(A) hexagonal close-packed structures. (B) 2 tetrahedral holes per atom.
(C) cubic close-packed structures. (D) primitive cubic structures.
(E) coordination numbers of 12.
- Which of the following is true?
(A) Butane, C_4H_{10} , has a higher boiling point than acetone, CH_3COCH_3
(B) CH_4 has a higher boiling point than CCl_4 .
(C) Pentane, C_5H_{12} , has a lower boiling point than 2,2-dimethylpropane, C_5H_{12} .
(D) CHF_3 has a higher boiling point than CF_4 .
(E) HI has a lower boiling point than HBr.
- What is the shape of ClO_3^- ?
(A) tetrahedral (B) square planar (C) seesaw (D) trigonal pyramidal (E) T-shaped
- How many moles of oxygen are necessary to burn 2.0 moles of benzene, C_6H_6 , to carbon dioxide and water?
(A) 8 (B) 10 (C) 11 (D) 13 (E) 15
- Which group has one element that behaves as a typical nonmetal while the rest are active metals?
(A) group 1 (B) group 3 (C) group 14 (D) group 15 (E) group 17
- Which of the following has the smallest molar mass?
(A) mRNA (B) dRNA (C) rRNA (D) sRNA (E) tRNA
- Choose the species with the most positive reduction potential.
(A) F_2 (B) Cl_2 (C) Br_2 (D) I_2 (E) O_2
- F_2 is a better oxidizing agent than Cl_2 in the gas phase principally because:
(A) F_2 has a weaker bond than Cl_2 (B) F_2 has a stronger bond than Cl_2
(C) the electron affinity of F is greater than that of Cl (D) the electronegativity of Cl is greater than that of F (E) the ionization energy for F is greater than that of Cl
- Which metal has a d^5 electron configuration?
(A) Pd^{2+} (B) Ag^+ (C) Fe^{3+} (D) OS^{2+} (E) Co^{2+}
- Which of the following complexes can exhibit the phenomenon of optical isomerism?
(A) $Co(NH_3)_4Cl_2$ (B) $[CoCl_6]^{4-}$ (C) $[Fe(H_2O)_6]^{3+}$ (D) $[Ni(SCN)_3Br_3]^{4-}$ (E) $[Mn(oxalate)_2Br_2]^{4-}$
- Electron capture transforms 7_4Be into what nuclide?
(A) 6_3Li (B) 7_5B (C) 7_3Li (D) 6_5B (E) ${}^{12}_6C$

(背面仍有題目，請繼續作答)

13. Which of the following compound has aldehyde functional group in it?
(A) Chloroform (B) Tetrahydrofuran (C) Acetone (D) Formic acid (E) Acetic acid
14. In going from conditions of STP to the conditions 0°F and 760 pascals (1 atm = 101.325 kilopascals), the density of argon will
(A) increase less than 10% (B) not change (C) decrease more than 10%
(D) decrease less than 10% (E) increase more than 10%
15. Choose the couple which is not a conjugate acid-base pair.
(A) HCO_3^- , CO_3^{2-} (B) H_3O^+ , H_2O (C) OH^- , O^{2-} (D) H_3PO_4 , HPO_4^{2-} (E) NH_2OH_2^+ , HPO_4^{2-}
16. Given: $\text{HCN}(\text{aq}) + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{CN}^-(\text{aq}) + \text{H}_2\text{CO}_3(\text{aq})$, If $K < 1$, what is the strongest base in this system? (A) HCN (B) HCO_3^- (C) CN^- (D) H_2CO_3 (E) H_2O
17. For a solution equimolar in HCN and NaCN, which statement is false?
(A) This is an example of the common ion effect. (B) The $[\text{H}^+]$ is equal to the K_a
(C) The $[\text{H}^+]$ is larger than it would be if only the HCN was in solution.
(D) Addition of NaOH will increase $[\text{CN}^-]$ and decrease $[\text{HCN}]$
(E) Addition of more NaCN will shift the acid dissociation equilibrium of HCN to the left
18. For ammonia, $K_b = 1.8 \times 10^{-5}$. To make a buffer solution of pH 10.0, the NH_4Cl to NH_3 ratio is:
(A) 9 : 5 (B) 5 : 9 (C) 9 : 50 (D) 50 : 9 (E) 18 : 50
19. Which of the following properties is/are intensive properties?
I. Mass II Temperature III. Volume IV. Concentration V Energy
(A) I, III, and IV (B) II only (C) II and IV (D) III and IV (E) I and V
20. For which process is ΔS negative?
(A) evaporation of 1 mol of $\text{CCl}_4(\text{l})$ (B) mixing 5 mL ethanol with 25 mL water
(C) grinding a large crystal to powder
(D) compressing 1 mol Ne at constant temperature from 1.5 atm to 0.5 atm
(E) raising the temperature of 100 g Cu from 275 K to 295 K
21. When the equation $\text{MnO}_4^-(\text{aq}) + \text{CN}^-(\text{aq}) \rightarrow \text{MnO}_2(\text{s}) + \text{CNO}^-(\text{aq})$ in basic solution is balanced, what is the sum of the coefficients?
(A) 9 (B) 10 (C) 11 (D) 12 (E) 13
22. The hybridization of I in IF_4^- is
(A) sp^2 (B) sp^3 (C) dsp^2 (D) dsp^3 (E) d^2sp^3
23. In the unit cell of sphalerite, Zn^{2+} ions occupy half the tetrahedral holes in a face-centered cubic lattice of S^{2-} ions. The number of formula units of ZnS in the unit cell is:
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5
24. Which of the following is not a structural isomer of 1-pentene?
(A) 2-pentene (B) 2-methyl-2-butene (C) cyclopentane (D) 3-methyl-1-butene
(E) 1-methyl-cyclobutene

二、簡答題（每題四分共二十八分，計算題請列式）

1. A radioactive sample has an initial activity of 2.00×10^6 cpm (counts per minute), and after 4 days its activity is 9.0×10^5 cpm, calculate its activity after 40 days.
2. A 50.0 mL sample of 0.10 M silver nitrate is added to 50.0 mL of 0.20 M calcium chloride. A white precipitate forms. Calculate the concentration of Cl^- ions remaining in solution.
3. For the reaction $\text{CO}_{(g)} + \text{Cl}_{2(g)} \rightleftharpoons \text{COCl}_{2(g)}$, at a particular temperature, $K = 5.1 \times 10^9$ when all concentrations are expressed in moles/liter. Pure COCl_2 is added to a 1-L flask. At equilibrium it is found that 0.25 moles of COCl_2 remain. Calculate the equilibrium concentration of CO .
4. One mole of an ideal gas is expanded from a volume of 1.00 liter to a volume of 10.00 liters against a constant external pressure of 1.00 atm. How much work (in joules) is performed on the surroundings? ($T = 300 \text{ K}$) $1 \text{ L atm} = 101.3 \text{ J}$
5. Consider 1.00 mole of an ideal gas which undergoes a change in pressure from 2.50 atm to 6.50 atm. Assuming this process to be isothermal (27°C) and reversible, calculate w for this process in kJ.
6. What is the correct (IUPAC) name of 3-methyl-4-isopropylpentane?
7. Write equations to explain why the carbon-14 is remained constant in our environment? (Hint: formation and fate)