

說明：1. 答案一律寫在試卷上，否則不予計分。
2. 請依序清楚作答、並標明題號。

一、選擇題：(共 68 分，每題 2 分，答錯不倒扣。)

- The reaction $\text{KHC}_8\text{H}_4\text{O}_4(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{KNaC}_8\text{H}_4\text{O}_4(\text{aq})$ is classified as a(n)
(A) precipitation reaction (B) acid-base reaction
(C) oxidation-reduction reaction (D) none of the above
- Which of the following solutions will have the highest electrical conductivity?
(A) 0.1 M $\text{CH}_3\text{COOH}(\text{aq})$ (B) 0.1 M $\text{NaCl}(\text{aq})$ (C) 0.07 M $\text{Na}_3\text{PO}_4(\text{aq})$ (D) 1.0 M sucrose
- Which of the following is not a valid set of quantum numbers?
(A) $n=2, l=1, m_l=-1, m_s=-\frac{1}{2}$ (B) $n=3, l=0, m_l=0, m_s=-\frac{1}{2}$ (C) $n=3, l=2, m_l=3, m_s=\frac{1}{2}$
(D) $n=2, l=0, m_l=0, m_s=-\frac{1}{2}$
- Which of the following is ground state electronic configuration for a Ni atom?
(A) $[\text{Ar}]4s^24d^8$ (B) $[\text{Kr}]4s^24d^8$ (C) $[\text{Ar}]4s^23d^8$ (D) $[\text{Ar}]3s^23d^8$
- Which of the following species will have the highest ionization energy?
(A) Na^+ (B) Ne (C) F^- (D) O^{2-}
- Which of the following substances contains an atom that does not obey the octet rule?
(A) NH_4^+ (B) SO_3^{2-} (C) ClF_3 (D) O_3
- In the best Lewis structure for ClO_3^- , the formal charge on Cl is
(A) 0 (B) 1 (C) 2 (D) -1
- What is the hybridization of the oxygen atom in $\text{H}_3\text{C}-\text{O}-\text{CH}_3$?
(A) sp (B) sp^2 (C) sp^3 (D) sp^3d
- Which of the following molecules is unstable in the gas phase?
(A) Li_2 (B) Be_2 (C) B_2 (D) C_2
- Which combination always results in a process being spontaneous?
(A) enthalpy change is negative and entropy change is negative
(B) enthalpy change is positive and entropy change is position
(C) enthalpy change is positive and entropy change is negative
(D) enthalpy change is negative and entropy change is positive
- Which of the following substances should have the largest lattice energy?
(A) CsCl (B) KBr (C) CaO (D) BeO

(背面仍有題目,請繼續作答)

12. Which of the following gases will have the highest root-mean-square speed under identical conditions?
(A) H₂O (B) Ne (C) Xe (D) He
13. Which one of the following molecules does not have a dipole moment?
(A) SO₂ (B) NO (C) CCl₄ (D) H₂S
14. Which of the following aqueous solutions will have the lowest freezing point?
(A) 0.10 m NaCl (B) 0.15 m sucrose (C) 0.10 m CaCl₂ (D) 0.05 m Na₃PO₄
15. The osmotic pressure of an aqueous solution is measured. Some of the water is then allowed to evaporate. How will the osmotic pressure of the new solution compare to that of the old?
(A) larger (B) smaller (C) same magnitude
(D) cannot be determined from the information provided
16. Cerium(IV) ion reacts with thallium(I) ion in a one step reaction
$$2 \text{Ce}^{4+}(\text{aq}) + \text{Tl}^{+}(\text{aq}) \rightarrow 2 \text{Ce}^{3+}(\text{aq}) + \text{Tl}^{3+}(\text{aq})$$

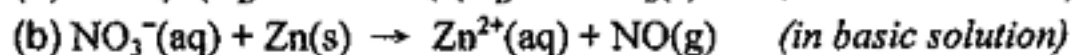
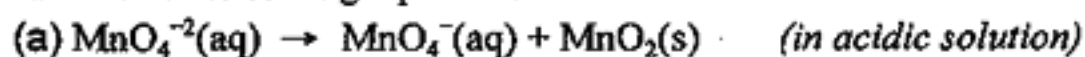
What is the overall order of the reaction?
(A) 1 (B) 2 (C) 3 (D) 4
17. Which of the following does not affect the rate of a reaction?
(A) concentrations of reactions (B) temperature
(C) presence of a catalyst (D) all of the above affect the rate
18. For which of the following equilibrium reactions will $K_c = K_p$?
(A) $\text{CO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}$ (B) $\text{ZnO}(\text{s}) + \text{CO}(\text{g}) \rightleftharpoons \text{Zn}(\text{l}) + \text{CO}_2(\text{g})$
(C) $2 \text{O}_3(\text{g}) \rightleftharpoons 3 \text{O}_2(\text{g})$ (D) $\text{COCl}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{Cl}_2(\text{g})$
19. A catalyst increases the rate of a chemical by providing a lower-energy mechanism for the reaction. When this occurs which one of the following is not affected?
(A) activation energy for the forward reaction (B) equilibrium constant
(C) activation energy for the reverse reaction (D) rate of the reverse reaction
20. Which one of the following species acts as an acid in water?
(A) NaH (B) NH₄⁺ (C) CH₃NH₂ (D) C₆H₆
21. Which one of the following salts forms an acidic solution when dissolved in water?
(A) NH₄Cl (B) LiCl (C) NaCl (D) KCl
22. Which of the following combinations of chemicals could be used to make a buffer solution?
(A) HCl/NaOH (B) HCl/NH₃ (C) HCl/H₃PO₄ (D) none of the above

23. For which of the following will the entropy increase?
(A) condensation (B) reaction of magnesium with oxygen to form magnesium oxide
(C) sublimation of dry ice (D) reaction of nitrogen and hydrogen to form ammonia
24. The following two reactions occur in a galvanic cell. At standard conditions, what species are produced at the electrodes?
$$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag} \quad E^\circ = 0.80 \text{ V}$$
$$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu} \quad E^\circ = 0.34 \text{ V}$$

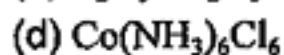
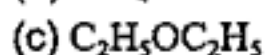
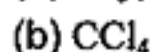
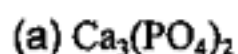
(A) Ag at cathode and Cu at anode (B) Ag at cathode and Cu^{2+} at anode
(C) Ag^+ at anode and Cu at cathode (D) Ag^+ at anode and Cu^{2+} at cathode
25. Which of the following species has its N atom or atoms in the -1 oxidation state?
(A) N_2H_4 (B) NH_2OH (C) N_2O (D) HONO
26. What is the oxidation state of Cr in $[\text{Ni}(\text{en})_3][\text{Cr}(\text{CN})_6]_2$?
(A) +2 (B) +3 (C) +6 (D) none of the above
27. Which of the following complex ions is colorless?
(A) $\text{Co}(\text{H}_2\text{O})_6^{2+}$ (B) $\text{Mn}(\text{CN})_6^{3-}$ (C) $\text{CrCl}_3(\text{H}_2\text{O})_3$ (D) $\text{Ag}(\text{NH}_3)_2^+$
28. The number of neutrons in $^{55}\text{Fe}_{26}$ is
(A) 26 (B) 29 (C) 55 (D) none of the above
29. Radiation from radioactive species is dangerous to organisms because
(A) it cause nuclear reactions in the cells (B) it ionizes molecules in the cells
(C) all radionuclides are poisonous (D) none of the above
30. How many isomers are there of C_4H_8 ?
(A) 3 (B) 4 (C) 5 (D) 6
31. Which of the following molecules is the most polar?
(A) ethane (B) ethylene (C) acetaldehyde (D) acetic acid
32. Which of the following molecules is the most highly oxidized?
(A) ethanol (B) 1,2-ethanediol (C) acetaldehyde (D) acetic acid
33. Which of the following molecules contains a chiral carbon?
(A) 1,3,5-trichlorobenzene (B) 4-chloroheptane (C) 2-bromobutane
(D) 2,4-dimethylpentane
34. How many unpaired electrons are present in the gaseous molecule B_2 ?
(A) 0 (B) 1 (C) 2 (D) 3

二、簡答題：（共 16 分，每題 8 分）

1. Balance the following equations.



2. Name the following species (in English).



三、計算題：（共 16 分，每題 4 分，必列出計算過程，否則不予計分）

1. The reaction of an organic ester with a strong base is second order with a rate constant equal to $4.50 \text{ L}\cdot\text{mol}^{-1}\cdot\text{min}^{-1}$. If the initial concentrations of ester and base are both 0.200 M, what is the ester concentration remaining after 10.0 minutes?

2. At 25°C , K_{sp} for PbSO_4 is 2.8×10^{-13} . Calculate the standard free-energy change at 25°C for the reaction: $\text{PbSO}_4(\text{s}) \rightleftharpoons \text{Pb}^{2+}(\text{aq}) + \text{CrO}_4^{2-}(\text{aq})$. ($R = 8.314 \text{ J/K}$)

3. Calculate the pH of a solution that is a mixture of 0.100 M acetic acid and 0.100 M sodium acetate. (acetic acid: $K_a = 1.80 \times 10^{-5}$)

4. Calculate the de Broglie wavelength of a $9.11 \times 10^{-31} \text{ kg}$ electron moving at 2% of the speed of light. ($c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$, $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$)