

說明：1. 答案一律寫在答案卷上；請依序作答，並標明題號。

2. 1~15 題為單選題，每題 4 分；答錯倒扣 1/4 題分。

- Which of the following is predicted by the MO model to be unstable diatomic species ?
(A) H_2^+ (B) H_2^- (C) Be_2 (D) B_2 (E) C_2
- The reaction $2 NO_{(g)} + O_{2(g)} \rightarrow 2 NO_{2(g)}$ with the proposed mechanism :
 $NO_{(g)} + O_{2(g)} \leftrightarrow NO_{3(g)}$ Fast equilibrium
 $NO_{3(g)} + O_{2(g)} \rightarrow 2 NO_{2(g)}$ Slow reaction
What is the rate law of this reaction?
(A) $k[NO]^2[O_2]$ (B) $k[NO]^2$ (C) $k[NO][O_2]$ (D) $k[NO][O_2]^2$ (E) $k[NO][NO_3]$
- If a particle is confined to a one-dimension box of length 300 pm, for Ψ_3 the particle is most likely to be found at
(A) 75 pm (B) 100 pm (C) 125 pm (D) 175 pm (E) 250 pm
- The equilibrium constants (K_a) for HCN and HF in H_2O at $25^\circ C$ are 6.2×10^{-10} and 7.2×10^{-4} , respectively. The relative order of base strengths is:
(A) $F^- > H_2O > CN^-$ (B) $H_2O > F^- > CN^-$ (C) $CN^- > F^- > H_2O$ (D) $F^- > CN^- > H_2O$
- In pure liquid ammonia, the equilibrium concentrations of both $[NH_4^+]$ and $[NH_2^-]$ are $3 \times 10^{-14} M$ at $25^\circ C$. Which of the following equations holds for liquid ammonia solutions at $25^\circ C$?
(A) $pNH_4^+ + pNH_2^- = 13.5$ (B) $pNH_4^+ = pNH_2^- = 13.5$ (C) $pNH_4^+ = 27.0$ (D) $pNH_4^+ = 27.0 - pNH_2^-$ (E) $pNH_4^+ = \log [pNH_4^+]$
- For a particular chemical reaction
 $\Delta H = 5.5 \text{ kJ}$ and $\Delta S = -25 \text{ J/K}$
Under what temperature condition is the reaction spontaneous?
(A) When $T < -200 \text{ K}$. (B) When $T < 220 \text{ K}$. (C) The reaction is spontaneous at all temperatures. (D) The reaction is not spontaneous at any temperature. (E) When $T > 220 \text{ K}$.
- For a reaction in a voltaic cell both ΔH° and ΔS° are positive. Which of the following statements is true?
(A) E°_{cell} will increase with an increase in temperature. (B) E°_{cell} will decrease with an increase in temperature. (C) E°_{cell} will not change when temperature increases. (D) $G^\circ > 0$ for all temperatures. (E) None of the above statements is true.
- Given that $E^\circ = -0.44 \text{ V}$ for $Fe^{+2}(aq) + 2 e^- \rightarrow Fe(s)$, and $E^\circ = 0.77 \text{ V}$ for $Fe^{+3}(aq) + e^- \rightarrow Fe^{+2}(aq)$. Calculate E° for $Fe^{+3}(aq) + 3 e^- \rightarrow Fe(s)$.
(A) -0.22 V (B) -0.037 V (C) 0.33 V (D) 0.11 V (E) -0.11 V
- Choose the element that is the strongest reducing agent in aqueous solution.
(A) Li (B) Na (C) K (D) Rb (E) Cs

(背面仍有題目,請繼續作答)

10. The compound SiO_2 does not exist as a discrete molecule while CO_2 does. This can be explained because
 (A) The Si—O bond is unstable. (B) the Lewis structure of SiO_2 has an even number of electrons. (C) the SiO_2 is a solid while CO_2 is a gas. (D) the 3p orbital of the Si has little overlap with the 2p of the O. (E) none of these
11. 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 for Cl.
12. Which of the following is optically active (i.e., chiral)?
 (A) 2-chloropropane (B) 3-chloropentane (C) 3,3-dichlorohexane (D) $[\text{CoCl}_6]^{3-}$ (E) $[\text{Co}(\text{en})_3]^{3+}$
13. Which of the following ligands might give linkage isomers? I. NO_2^- II. SCN^- III. $\text{H}_2\text{N}-\text{H}_2\text{C}-\text{CH}_2-\text{NH}_2$
 (A) I, II (B) I, III (C) II, III (D) NONE (E) I, II, III
14. The molecular formula of an alkane that exists as three and only three isomers is:
 (A) C_2H_6 (B) C_3H_8 (C) C_4H_{10} (D) C_5H_{12} (E) C_6H_{14}
15. Which of the following statements about the packing of monoatomic solids with different unit cells is INCORRECT?
 (A) The coordination number of atoms in hcp and fcc structure is 12 (B) The coordination number of atoms in simple cubic structure is 6 (C) The coordination number of atoms in bcc structure is 8 (D) A bcc structure has a higher packing efficiency than a simple cubic structure (E) A bcc structure has a higher packing efficiency than a fcc structure
16. Sketch the shapes of the following: 8%
 (A) ICl_4^- (B) BrF_5 (C) PCl_3Br_2 (D) XeOF_4
17. Baking powder is a mixture of aluminum sulfate and sodium hydrogen carbonate, which generates a gas and makes bubbles in biscuit dough. Explain what the reactions are. 6%
18. Bromthymol blue, an indicator with a K_a value of 1.0×10^{-7} , is yellow in its HIn form and blue in its In^- form. Suppose we put a few drops of this indicator in a strongly acidic solution. If the solution is then titrated with NaOH , at what pH will the indicator color change first be visible? 8%
19. One mole of an ideal gas with a volume of 1.0 L and a pressure of 5.0 atm is allowed to expand isothermally into an evacuated bulb to give a total volume of 2.0 L. Calculate w and q . Also calculate q_{rev} for this change of state.
 ($R = 0.08206 \text{ L atm/K mol} = 8.314 \text{ J/K mole}$; $\log 2 = 0.3010$) 10%
20. Would it be better to use octahedral Ni^{2+} complexes or octahedral Cr^{2+} complexes to determine whether a ligand is a high-field or low-field ligand by determining experimentally the number of unpaired electrons? 8%