

- 說明： 1. 答案一律寫在試卷上，否則不予計分。
2. 請依序作答、並標明題號，但不必抄題。
3. 計算題必須寫出計算過程，否則不予計分。

一、選擇題：(30%，不倒扣，每題3分)

- The number of isomeric forms for the $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ complex is
(a) one (b) two (c) three (d) four (e) five.
- If the molar solubility of a slight soluble hypothetical salt MX_2 is given by x , the K_{sp} is equal to
(a) $4x^3$ (b) $x^3/4$ (c) $2x^3$ (d) $x^3/2$ (e) $x^3/8$.
- Predict the structure and polarity of the SO_2 molecules.
(a) linear, polar (b) linear, nonpolar (c) bent, polar (d) bent, nonpolar
(e) none of the above
- Which one has the smallest first ionization energy in the following atoms?
(a) He (b) Na (c) Ar (d) Rb (e) Xe
- The bonding orbital that results from the association of two s orbitals is given the symbol
(a) σs (b) σ^*s (c) σp (d) σ^*p (e) π^*p .
- If a process is both endothermic and spontaneous then
(a) $\Delta S > 0$ (b) $\Delta S < 0$ (c) $\Delta H < 0$ (d) $\Delta G > 0$ (e) $\Delta E = 0$.
- If an ideal gas is expanded at constant pressure
(a) $\Delta E > 0$ and $\Delta S > 0$ (b) $\Delta E = 0$ and $\Delta S = 0$ (c) $\Delta E = 0$ and $\Delta S < 0$
(d) $\Delta E < 0$ and $\Delta S > 0$ (e) $\Delta E = 0$ and $\Delta S > 0$
- For the reaction $\text{A} + 2\text{B} \rightarrow 2\text{C}$, the rate law for formation of C is
(a) $\text{rate} = k[\text{A}][\text{B}]^2$ (b) $\text{rate} = k[\text{A}][\text{B}]$ (c) $\text{rate} = [\text{C}]^2/[\text{A}][\text{B}]^2$
(d) $\text{rate} = k[\text{A}]^2[\text{B}]$ (e) impossible to state from the data given.
- What is the following statements about a reaction occurring in a galvanic cell is true?
(a) If $\Delta \mathcal{E}_{\text{cell}} > 0$, $\Delta G < 0$ (b) If $\Delta \mathcal{E}_{\text{cell}} < 0$, $\Delta G < 0$ (c) If $\Delta \mathcal{E}_{\text{cell}} < 0$, $K_{eq} > 1$
(d) If $\Delta \mathcal{E}_{\text{cell}} < 0$, $K_{eq} > 1$ (e) If $\Delta \mathcal{E}_{\text{cell}} > 0$, $K_{eq} > 1$
- Which of the following compounds contains both covalent and ionic bonds?
(a) CCl_4 (b) HOH (c) NaOH (d) NaCl (e) CH_3COOH (e) none of the above

(下接第二頁)

二、問答與計算：(70%)

- Write the chemical formulas for the following compounds: (8%)
(a) chloric acid (b) copper (II) sulfate pentahydrate
(c) polystyrene (d) sodium hexacyanoferrate (II)
- Classify the following oxides as acidic, basic, or amphoteric: (a) Rb_2O , (b) BeO , (c) As_2O_5 , and explain briefly. (6%)
- Give the *electronic configuration*, the *bond order* and the *magnetic property* for each of the following, and predict whether it will be a *stable or unstable* molecule.
(a) H_2^+ (b) He_2 (c) O_2 (6%)
- Write the half reactions of oxidation and reduction for rust ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$) formation. (4%)
- Please list six different units of "energy" such as *Joule*. (3%)
- What is the *photoelectric effect*? Explain it in detail (including the frequency and intensity of the incident light). Who introduced it to the quantum concept? (6%)
- The police often use a breath analyzer to test drivers suspected of being drunk. The chemical basis of it is a redox reaction. The alcohol (ethanol) in the breath is converted to acetic acid in the presence of potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and sulfuric acid. Please balance this chemical reaction. (5%)
- Predict the *number of unpaired electrons* in the following complex ions:
(a) $[\text{Cr}(\text{CN})_6]^{4-}$ (b) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$ (c) $[\text{Fe}(\text{CN})_6]^{4-}$ (6%)
- How many oxidation states (or oxidation numbers) of nitrogen element (N)? Give an example for each oxidation state. (5%)
- Calculate the *energy* (in cm^{-1}) and the *wavelength* (in nm) of H_α line in atomic hydrogen emission spectrum. (Rydberg constant of hydrogen $R = 109678 \text{ cm}^{-1}$) (5%)
- The conversion of cyclopropane to propene in the gas phase is a first-order reaction with a constant of $6.7 \times 10^{-4} \text{ s}^{-1}$ at 500°C . Calculate the half-life ($t_{1/2}$) of the reaction. (5%)
- What are the concentration of H^+ ion and percentage hydrolysis of a $0.10 \text{ M NH}_4\text{Cl}$ solution? (K_a of $\text{NH}_4^+ = 5.6 \times 10^{-10}$) (5%)
- The molar solubility of $\text{Mg}(\text{OH})_2$ in pure water is $1.4 \times 10^{-4} \text{ M}$ at 25°C . Calculate its molar solubility in a buffer medium whose pH is (a) 12.00 and (b) 9.00 (6%)