

- 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)

1. 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.
2. 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) $x^3/8$.
3. 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
4. Which one has the smallest first ionization energy in the following atoms?
(a) He (b) Na (c) Ar (d) Rb (e) Xe
5. 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 .
6. 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) $\Delta E = 0$.
7. 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 $\Delta S > 0$
8. 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.
9. 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 $\Delta \mathcal{E}^\circ_{\text{cell}} < 0$, $\Delta G < 0$ (c) If $\Delta \mathcal{E}^\circ_{\text{cell}} < 0$, $K_{eq} > 1$
(d) If $\Delta \mathcal{E}_{\text{cell}} < 0$, $K_{eq} > 1$ (e) If $\Delta \mathcal{E}_{\text{cell}} > 0$, $K_{eq} > 1$
10. 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%)