

- 注意事項： 1. 答案一律寫在試卷上，否則不予計分。
2. 請標明題號依序作答，不必抄題。

※ 1-10 題每題 3 分，答錯不倒扣

- The hybridization of I in IF_4^- is
 - sp
 - sp^2
 - dsp^3
 - dsp^3
 - d^2sp^3
- The fact that O_2 is paramagnetic can be explained by
 - the Lewis structure of O_2 .
 - resonance.
 - a violation of the octet rule.
 - the molecular orbital diagram for O_2 .
 - hybridization of atomic orbitals in O_2 .
- Sodium oxide (Na_2O) crystallizes in a structure in which the O^{2-} ions are in a face-centered cubic lattice and the Na^+ ions are in tetrahedral holes. The number of Na^+ ions in the unit cell is:
 - 2
 - 4
 - 6
 - 8
- A material is made from Al, Ga, and As. The mole fraction of each element is 0.25, 0.26, and 0.49, respectively. This material would be
 - a metallic conductor because Al is present.
 - an insulator.
 - a p -type semiconductor.
 - an n -type semiconductor.
- The equilibrium constants (K_b) for HCN and HF in H_2O at 25°C are 6.2×10^{-10} and 7.2×10^{-4} , respectively. The relative order of base strengths is:
 - $\text{F}^- > \text{H}_2\text{O} > \text{CN}^-$
 - $\text{H}_2\text{O} > \text{F}^- > \text{CN}^-$
 - $\text{CN}^- > \text{F}^- > \text{H}_2\text{O}$
 - $\text{F}^- > \text{CN}^- > \text{H}_2\text{O}$
- In pure liquid ammonia the equilibrium concentrations of both NH_4^+ and NH_2^- are 3×10^{-14} M. Which of the following equations will always be true in liquid ammonia solutions?
 - $\text{pNH}_4^+ + \text{pNH}_2^- = 13.5$
 - $\text{pNH}_4^+ = \text{pNH}_2^- = 13.5$
 - $\text{pNH}_4^+ = 27.0 - \text{pNH}_2^-$
 - $\text{pNH}_4^+ = 27.0$
 - $\text{pNH}_4^+ = \log [\text{pNH}_4^+]$
- Consider the titration of equal volumes of 0.1 M HCl and 0.1 M $\text{HC}_2\text{H}_3\text{O}_2$ with 0.1 M NaOH. Which of the following would be the same for both titrations?
 - the initial pH
 - the pH at the halfway point
 - the pH at the equivalence point
 - the volume of NaOH added to reach the equivalence point
- For a particular chemical reaction

$$\Delta H = 5.5 \text{ kJ and } \Delta S = -25 \text{ J/K}$$
 Under what temperature conditions is the reaction spontaneous?
 - When $T < -220 \text{ K}$.
 - When $T < 220 \text{ K}$.
 - When $T > 220 \text{ K}$.
 - The reaction is not spontaneous at any temperature.
 - The reaction is spontaneous at all temperatures.
- Which of the following is true for the cell shown here?

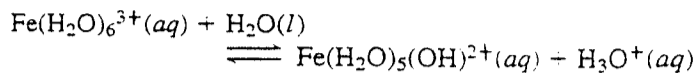
$$\text{Zn(s)} \mid \text{Zn}^{2+}(\text{aq}) \parallel \text{Cr}^{3+}(\text{aq}) \mid \text{Cr(s)}$$
 - The electrons flow from the cathode to the anode.
 - The electrons flow from the zinc to the chromium.
 - The electrons flow from the chromium to the zinc.
 - The chromium is oxidized.
 - The zinc is reduced.
- Which of the following transition metal complexes can exhibit the phenomenon of optical isomerism?
 - $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$
 - $[\text{Co}(\text{Cl})_6]^{3-}$
 - $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 - $[\text{Ni}(\text{SCN})_3\text{Br}_3]^+$
 - $[\text{Mn}(\text{oxalate})_2\text{Br}_2]^+$

(背面仍有題目,請繼續作答)

11. Using the molecular orbital model, write electron configurations for the following diatomic species and calculate the bond orders. Which ones are paramagnetic? (8%)

- a. NO^+ b. NO c. NO^-

12. The equilibrium constant K_a for the reaction



is 6.0×10^{-3} .

- a. Calculate the pH of a 0.10 M solution of $\text{Fe}(\text{H}_2\text{O})_6^{3+}$. (6%)
b. Will a 1.0 M solution of iron(II) nitrate have a higher or lower pH than a 1.0 M solution of iron(III) nitrate? Explain. (6%)

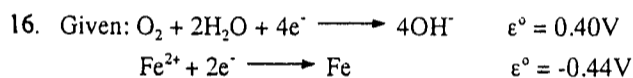
13. Changing the temperature of a reaction from 275 to 300. K causes the rate constant to increase by a factor of 10.0 Calculate E_a for this reaction. (8%)

14. For the reaction



- a. Predict the signs of ΔH and ΔS . (2%)
b. Would the reaction be more spontaneous at high or low temperatures? Explain. (4%)

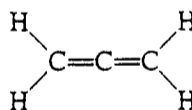
15. Which is larger: ΔS at constant pressure or ΔS at constant volume? Provide a conceptual rationale. (6%)



Write the Nernst equation for the corrosion of iron by oxygen. Will corrosion be a greater problem in an acidic or a basic solution? Explain your answer. (10%)

17. The complex ion NiCl_4^{2-} has two unpaired electrons, while $\text{Ni}(\text{CN})_4^{2-}$ is diamagnetic. Propose structures for these two complex ions. (8%)

18. The allene molecule has the following Lewis structure:



Are all four hydrogen atoms in the same plane? If not, what is their spatial relationship? Explain. (6%)

19. Give the structure for each of the following. (6%)

- a. Benzaldehyde b. 2,3,3-Trimethyl-1-hexene c. 2-Pentanone