

單選選擇題 (共三十題每題兩分)請於答案卷內之「選擇題作答區」依序作答。

- HCl gas is in a 1.21-L cylinder at 0.870 atm and 28.0° C. This gas is dissolved in 750.0 mL of water. Calculate the pH of this solution (assume no volume change).
(A) 1.25 (B) 3.37 (C) 2.52 (D) 0.950 (E) 4.11
- Addition of AgNO_3 to aqueous solutions of the complex results in a cloudy white precipitate, presumably AgCl . You dissolve 0.1000 g of the complex in H_2O and perform a precipitation titration with 0.0500 M AgNO_3 as the titrant. Using an electrode that is sensitive to $[\text{Ag}^+]$, you reach the endpoint after 9.00 mL of titrant is added. How many grams of chloride ion were present in the 0.1000-g sample?
(A) 4.50×10^{-4} g (B) 5.00×10^{-3} g (C) 1.77×10^{-3} g (D) 6.38×10^{-2} g (E) 1.60×10^{-2} g
- The pH of a 0.120 M solution of a weak base is 10.97 at 25°C. Calculate the pH of a 0.0316 M solution of the base at 25°C.
(A) 2.89 (B) 10.68 (C) 10.39 (D) 11.54 (E) 3.32
- How many unpaired electrons are found in MnCl_4^{2-} (tetrahedral)?
(A) 0 (B) 1 (C) 2 (D) 4 (E) 5
- A 99.0-g sample of a metal is heated to 98.7°C and then placed in a calorimeter containing 395.0 g of water ($c = 4.18 \text{ J/g}^\circ\text{C}$) at 22.5°C. The final temperature of the water is 24.5°C. Which metal was used?
(A) aluminum ($C = 0.89 \text{ J/g}^\circ\text{C}$) (B) iron ($C = 0.45 \text{ J/g}^\circ\text{C}$) (C) copper ($C = 0.20 \text{ J/g}^\circ\text{C}$)
(D) lead ($C = 0.14 \text{ J/g}^\circ\text{C}$) (E) none of these

Use the following to answer questions 6-8: The vapor pressure of $\text{Br}_2(l)$ at 25°C is 0.281 atm, and 193 J is required to vaporize 1.00 g of bromine at 1 atm pressure.

- Calculate ΔH° for the vaporization of $\text{Br}_2(l)$ at 25°C and 1 atm.
(A) 0.193 kJ/mol (B) 30.8 kJ/mol (C) 15.4 kJ/mol (D) 1.21 kJ/mol (E) none of these
- Calculate ΔS° for the vaporization of $\text{Br}_2(l)$ at 25°C and 1 atm.
(A) 92.8 J/K•mol (B) 103 J/K•mol (C) 0 J/K•mol (D) 30.8 J/K•mol (E) none of these
- Calculate ΔG for the vaporization of $\text{Br}_2(l)$ at 25°C and 1 atm.
(A) 0.378 kJ/mol (B) 0.263 kJ/mol (C) 3.15 kJ/mol (D) 0 (E) none of these
- One mole of an ideal gas expands isothermally and reversibly at 0°C. The pressure on 1 mol of an ideal monatomic gas changes from 100.0 atm to 1.00 atm. Calculate w .
(A) 225 kJ (B) -225 kJ (C) 10.5 kJ (D) -10.5 kJ (E) 0
- 1.2 mol of an ideal gas at 304 K is compressed isothermally and reversibly from 1.8 L to 0.50 L. What is ΔS ?
(A) 13 J/K (B) -3.9 kJ/K (C) -11 J/K (D) -13 J/K (E) -6 J/K
- For the process involving compound A: $\text{A}(s) \rightarrow \text{A}(l)$, $\Delta H^\circ = 7.5 \text{ kJ/mol}$, and $\Delta S^\circ = 43.4 \text{ J/mol}\cdot\text{K}$. What is the melting point of compound A?
(A) -100°C (B) 173°C (C) -222°C (D) 100°C (E) -173°C
- In a common car battery, six identical cells each carry out the following reaction:
 $\text{Pb} + \text{PbO}_2 + 2\text{HSO}_4^- + 2\text{H}^+ \rightarrow 2\text{PbSO}_4 + 2\text{H}_2\text{O}$

- Suppose that to start a car on a cold morning, 136 amperes is drawn for 16.0 seconds from such a cell. How many grams of Pb are consumed?
(A) 9.35 g (B) 2.34 g (C) 4.67 g (D) 0.00913 g (E) 0.428 g
13. Which charge(s) of O_2 would give a bond order of 3?
(A) +1 (B) -2 (C) +2 (D) -1 (E) +3
14. Which of the following is diamagnetic?
(A) O_2^- (B) F_2^+ (C) NO_2 (D) CO_2 (E) NO
15. The bond order in the NO^+ ion is
(A) 1 (B) 1.5 (C) 2.5 (D) 3 (E) 2
16. Consider the second-order reaction $aA \rightarrow \text{products}$. If the concentration of A after 13.4 s is 0.46 M (which has a first half-life of 22 s), determine the initial concentration of A.
(A) 0.69 M (B) 0.58 M (C) 0.49 M (D) 0.86 M (E) 0.74 M
17. Elemental magnesium crystallizes in a face-centered cubic lattice. The density of magnesium is 1.738 g/cm^3 . The unit cell length is 4.80×10^2 pm. What is the atomic radius of Mg?
(A) 242 pm (B) 340 pm (C) 215 pm (D) 170 pm (E) 126 pm
18. A concentration cell is constructed using two Ni electrodes with Ni^{2+} concentrations of 1.64 M and 2.85×10^{-4} M in the two half-cells. The standard reduction potential of Ni^{2+} is -0.23 V. Calculate the potential of the cell at 25°C.
(A) +0.341 V (B) -0.222 V (C) -0.256 V (D) +0.111 V (E) -0.0078 V
19. ΔH_{vap} for water is 40.7 kJ/mol. Calculate the boiling point of water at 0.500 atm.
(A) 50.0°C (B) 81.3°C (C) 98.6°C (D) 60.0°C (E) 72°C
20. Thyroxine, an important hormone that controls the rate of metabolism in the body, can be isolated from the thyroid gland. If 0.455 g of thyroxine is dissolved in 10.0 g of benzene, the freezing point of the solution is 5.144°C. Pure benzene freezes at 5.444°C and has a value for the molal freezing-point-depression constant of K_f of 5.12°C/m. What is the molar mass of thyroxine?
(A) 777,000 g/mol (B) 777 g/mol (C) 2330 g/mol (D) 285 g/mol (E) 3760 g/mol
21. What reason is given for the stability of C—C, N—N, and O—O bonds, compared to the instability of Si—Si, P—P, and S—S bonds?
(A) Their metallic character varies greatly.
(B) There are large differences in their ionization energies.
(C) There are large differences in their electronegativities.
(D) There are large differences in their abilities to form strong pi bonds.
(E) none of these
22. Choose the correct molecular structure for XeF_6 .
(A) trigonal bipyramidal (B) trigonal planar (C) tetrahedral (D) octahedral (E) none of these
23. Choose the correct molecular structure for SF_4 .
(A) trigonal bipyramidal (B) trigonal planar (C) tetrahedral (D) octahedral (E) none of these
24. Which of the following is a d^3 ion?
(A) Cr^{3+} (B) Ti^+ (C) Mn^{3+} (D) Cr^{2+} (E) Fe^{3+}

25. The empirical formula of a compound with a mass percent composition of 6.78% H, 31.43% N, 39.76% Cl, and 22.03% Co is consistent with which of the following complexes?
 (A) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ (B) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ (C) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ (D) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
 (E) $[\text{Co}(\text{NH}_3)_2\text{Cl}_4]$
26. Give the number of geometric isomers for the octahedral compound $[\text{Ma}_2\text{B}_2\text{C}_2]$, where A, B, and C represent different ligands.
 (A) 1 (B) 2 (C) 3 (D) 5 (E) 6
27. How many unpaired electrons are there in the complex ion $[\text{Co}(\text{NO}_3)_6]^{4-}$? For this ion, the nitrate ligands produce a very strong crystal field.
 (A) 1 (B) 2 (C) 3 (D) 4 (E) 5
28. Which of the following transition metals is a component of vitamin B₁₂?
 (A) manganese (B) chromium (C) cobalt (D) copper (E) zinc
29. Which of the following oxides is amphoteric?
 (A) BeO (B) MgO (C) CaO (D) SrO (E) BaO
30. Which of the following is the oxidation state of nitrogen in nitrogen dioxide?
 (A) +4 (B) +5 (C) +3 (D) -5 (E) -3

計算題 · 共四題 40%

1. The equilibrium constant K for the distribution of iodine between CCl_4 and aqueous solution is $K = \frac{[\text{I}_2]_{\text{in CCl}_4}}{[\text{I}_2]_{\text{in aqueous solution}}} = 85$. An aqueous solution has an iodine concentration of $2.00 \times 10^{-3}\text{M}$. Calculate the percentage of iodine remaining in the aqueous phase after extraction of 0.100L of this aqueous solution with 0.050 L of CCl_4 at 25°C. (10%)
2. The composition of a sample of iron oxide is $\text{Fe}_{0.90}\text{O}_{1.00}$. What percentage of the iron is in the form of iron(III)? (5%)
3. Use appropriate theory to explain why the two diatomic molecules O_2 and B_2 are paramagnetic, while other diatomic molecules Li_2 , Be_2 , C_2 , N_2 and F_2 of the second period in the periodic table are diamagnetic. (15%)
4. At elevated temperature, reactant A reacts according to the chemical equation:

$$\text{A}_{(g)} \rightarrow \text{B}_{(g)} + \text{C}_{(g)}$$
 At 500°C, the rate of the reaction increases with concentration of A as follows:
- | | | | |
|------------|----------------------|----------------------|----------------------|
| [A] (M) | 0.0050 | 0.010 | 0.020 |
| Rate (M/s) | 1.5×10^{-3} | 1.2×10^{-2} | 9.6×10^{-2} |
- (a) Determine the order of the reaction and write the rate expression. (3%)
 (b) Calculate the rate constant, and give its units. (4%)
 (c) Calculate the reaction rate for a 0.0020M concentration of A. (3%)

Useful Data

The atomic mass (g/mol) of Pb: 207.19, Br: 79.90, Co: 58.93, Cl: 35.45, N: 14.00, H: 1.00.

R gas constant: 8.315 J/K mol or 0.08206 L atm/K mol; Faraday's constant: 96485 C/mol, 1 Ampere = 1C/s

試題隨卷繳回