

## 普通化學 試題

(限用答案本作答)

考生可使用計算機，常用的元素原子量如下

C: 12.01,

H: 1.008,

N: 14.01,

O: 16.00,

Mg: 24.3

## 一、解釋名詞 (10%)

1. buffer solution
2. Resonance
3. Mass Spectrometer
4. Chirality
5. Colligative properties

## 二、非選擇題 (90%)

1. Match each of the elements on the right with its description on the left: (5%)

(a). A greenish-yellow gas that reacts with water	Nitrogen (N <sub>2</sub> )
(b). A soft metal that reacts with water to produce hydrogen	Boron (B)
(c). A metalloid that is hard and has a high melting point	Aluminum (Al)
(d). A colorless, odorless gas	Fluorine (F <sub>2</sub> )
(e). A more reactive metal than iron, which does not corrode in air	Sodium (Na)

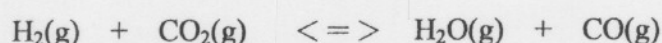
2. When 0.273 g of Mg is heated strongly in a nitrogen (N<sub>2</sub>) atmosphere, a chemical reaction occurs. The product of the reaction weighs 0.378 g. Calculate the empirical formula of the compound containing Mg and N. Name the compound. (4%)
3. A mixture of methane (CH<sub>4</sub>) and ethane (C<sub>2</sub>H<sub>6</sub>) of mass 13.43 g is completely burned in oxygen. If the total mass of CO<sub>2</sub> and H<sub>2</sub>O produced is 64.84 g, calculate the fraction of CH<sub>4</sub> in the mixture. (4%)
4. Ammonium nitrate (NH<sub>4</sub>NO<sub>3</sub>) is one of the most important nitrogen-containing fertilizers. Its purity can be analyzed by titrating a solution of NH<sub>4</sub>NO<sub>3</sub> with a standard NaOH solution. In one experiment a 0.2041 g sample of industrially prepared NH<sub>4</sub>NO<sub>3</sub> required 24.42 ml of 0.1023 M NaOH for neutralization. (a) Write a net ionic equation for the reaction. (b) What is the percent purity of the sample? (6%)
5. Calculate the work done in joules when 1.0 mole of water vaporizes at 1.0 atm and 100°C. Assume that the volume of liquid water is negligible compared with that of steam at 100°C, and ideal gas behavior. (4%)

本試題係兩面印刷

6. Which of these properties show a clear periodic variation? (a) first ionization energy, (b) molar mass of the elements, (c) number of isotopes of an element, (d) atomic radius. (8%)

7. Draw three resonance structures for the molecule N<sub>2</sub>O in which the atoms are arranged in the order NNO. Indicate formal charges. (9%)

8. Predict the bond angles for these molecules: (a)  $\text{BeCl}_2$ , (b)  $\text{BCl}_3$ , (c)  $\text{CCl}_4$ , (d)  $\text{CH}_3\text{Cl}$ , (e)  $\text{Hg}_2\text{Cl}_2$  (arrangement of atoms:  $\text{ClHgHgCl}$ ), (f)  $\text{SnCl}_2$ , (g)  $\text{H}_2\text{O}_2$ , (h)  $\text{SnH}_4$ . (8%)
9. Write the structural formulas for these organic compounds: (a) 3-methylhexane, (b) 1,3,5-trichlorocyclohexane, (c) 2,3-dimethylpentane, (d) 2-phenyl-4-bromopentane, (e) 3,4,5-trimethyloctane. (10%)
10. How much heat (in kilojoules) is needed to convert 866 g of ice at  $-10^\circ\text{C}$  to steam at  $126^\circ\text{C}$ ? (The specific heats of ice and steam are  $2.03 \text{ J/g} \cdot ^\circ\text{C}$  and  $1.99 \text{ J/g} \cdot ^\circ\text{C}$ , respectively.) (4%)
11. For ideal solutions, the volumes are additive. This means that if 5 ml of A and 5 ml of B form an ideal solution, the volume of the solution is 10 ml. Provide a molecular interpretation for this observation. When 500 ml of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) are mixed with 500 ml of water, the final volume is less than 1000 ml. Why? (4%)
12. The decomposition of  $\text{N}_2\text{O}$  to  $\text{N}_2$  and  $\text{O}_2$  is a first-order reaction. At  $730^\circ\text{C}$  the half-life of the reaction is  $3.58 \times 10^3$  min. If the initial pressure of  $\text{N}_2\text{O}$  is 2.10 atm at  $730^\circ\text{C}$ , calculate the total gas pressure after one half-life. Assume that the volume remains constant. (4%)
13. The equilibrium constant  $K_c$  for the reaction



is 4.2 at  $1650^\circ\text{C}$ . Initially 0.80 mol  $\text{H}_2$  and 0.80 mol  $\text{CO}_2$  are injected into a 5.0 L flask. Calculate the concentration of each species at equilibrium. (4%)

14. Use Le Châtelier's principle to predict the effect of the following changes on the extent of hydrolysis of sodium nitrite ( $\text{NaNO}_2$ ) solution: (a)  $\text{HCl}$  is added; (b)  $\text{NaOH}$  is added; (c)  $\text{NaCl}$  is added; (d) the solution is diluted. (8%)
15. Calculate  $x$ , the number of molecules of water in oxalic acid hydrate,  $\text{H}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ , from the following data: 5.00 g of the compound is made up to exactly 250 ml solution and 25 ml of this solution requires 15.9 ml of 0.500 M  $\text{NaOH}$  solution for neutralization. (4%)
16. Explain why chlorine gas can be prepared by electrolyzing an aqueous solution of  $\text{NaCl}$  but fluorine gas cannot be prepared by electrolyzing an aqueous solution of  $\text{NaF}$ . (4%)