

國立暨南國際大學九十二學年度博士班研究生入學考試試題

436 普通化學〈應化所適用〉

(本試題共 5 頁, 第 1 頁)

考生注意: 1. 依次序作答, 只要標明題號, 不必抄題。  
2. 答案必須寫在答案卷上, 否則不予計分。  
3. 試題隨卷繳回。

I Assembled Questions 1-12 (24%)

Questions 1-4 refer to the following types of energy.

(A) Activation energy (B) Free energy (C) Ionization energy (D) Kinetic energy (E) Lattice energy

1. The energy required to convert a ground-state atom in the gas phase to a gaseous positive ion
2. The energy change that occurs in the conversion of an ionic solid to widely separated gaseous ions
3. The energy in a chemical or physical change that is available to do useful work
4. The energy required to form the transition state in a chemical reaction

Question 5-8 refer to aqueous solutions containing 1:1 mole ratios of the following pairs of substances. Assume all concentrations are 1 M.

(A)  $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$  (B)  $\text{H}_3\text{PO}_4$  and  $\text{NaH}_2\text{PO}_4$  (C)  $\text{HCl}$  and  $\text{NaCl}$  (D)  $\text{NaOH}$  and  $\text{NH}_3$  (E)  $\text{NH}_3$  and  $\text{HC}_2\text{H}_3\text{O}_2$  (acetic acid)

5. The solution with the lowest pH
6. The most nearly neutral solution
7. A buffer at a pH > 8
8. A buffer at a pH < 6

Questions 9-12 refer to the following descriptions of bonding in different types of solids.

(A) Lattice of positive and negative ions held together by electrostatic forces.  
(B) Closely packed lattice with delocalized electrons throughout  
(C) Strong single covalent bonds with weak intermolecular forces.  
(D) Strong multiple covalent bonds (including bonds) with weak intermolecular forces  
(E) Macromolecules held together with strong polar bonds.

9. Cesium chloride,  $\text{CsCl}$  (s)
10. Gold,  $\text{Au}$  (s)
11. Carbon dioxide,  $\text{CO}_2$  (s)
12. Methane,  $\text{CH}_4$  (s)

(本試題共 5 頁, 第 2 頁)

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**II Multiple Choice (76%)**

Directions: Each of the questions or incomplete statements below is by five suggested answers or completions. Select the one that is best in each case and then write on the answer sheet.

13. Of the following reaction, which involves the largest decrease in entropy?

- (A)  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$   
 (B)  $2 \text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2$   
 (C)  $\text{Pb}(\text{NO}_3)_2 + 2 \text{KI} \rightarrow \text{PbI}_2 + 2 \text{KNO}_3$   
 (D)  $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}$   
 (E)  $4 \text{La} + 3 \text{O}_2 \rightarrow 2 \text{La}_2\text{O}_3$



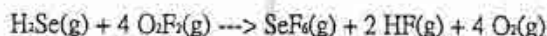
14. When the equation above is balanced and all coefficients are reduced to their lowest whole-number terms, the coefficient for  $\text{O}_2(\text{g})$  is?

- (A) 6 (B) 7 (C) 12 (D) 14 (E) 28

15. Appropriate uses of a visible-light spectrophotometer include which of the following?

- I. Determining the concentration of a solution of  $\text{Cu}(\text{NO}_3)_2$   
 II. Measuring the conductivity of a solution of  $\text{KMnO}_4$   
 III. Determining which ions are present in a solution that may contain  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$

- (A) I only (B) II only (C) III only (D) I and II only (E) I and III only



16. If the temperature of an aqueous solution of  $\text{NaCl}$  is increased from  $20^\circ\text{C}$  to  $90^\circ\text{C}$ , which of the following statements is true?

- (A) The density of the solution remains unchanged.  
 (B) The molarity of the solution remains unchanged.  
 (C) The molality of the solution remains unchanged.  
 (D) The mole fraction of solute decreases.  
 (E) The mole fraction of solute increases.

17. Types of hybridization exhibited by the C atoms in propene,  $\text{CH}_3\text{CHCH}_2$ , include which of the following?

- I.  $\text{sp}$  II.  $\text{sp}^2$  III.  $\text{sp}^3$

- (A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III

(本試題共 5 頁, 第 3 頁)

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3. 試題隨卷撤回。

Questions 18 refer to an electrolytic cell that involves the following half-reaction.



18. Which of the following occurs in the reaction?

- (A)  $\text{AlF}_6^{3-}$  is reduced at the cathode. (B) Al is oxidized at the anode. (C) Aluminum is converted from the -3 oxidation state to the 0 oxidation state. (D)  $\text{F}^-$  acts as a reducing agent. (E)  $\text{F}^-$  is reduced at the cathode.

Experiment	Initial [NO] (mol L <sup>-1</sup> )	Initial [O <sub>2</sub> ] (mol L <sup>-1</sup> )	Initial Rate of Formation of NO <sub>2</sub> (mol L <sup>-1</sup> s <sup>-1</sup> )
1	0.10	0.10	$2.5 \times 10^{-4}$
2	0.20	0.10	$5.0 \times 10^{-4}$
3	0.20	0.40	$8.0 \times 10^{-3}$

19. The initial-rate data in the table above were obtained for the reaction represented below. What is the experimental rate law for the reaction?

- (A)  $\text{rate} = k[\text{NO}][\text{O}_2]$  (B)  $\text{rate} = k[\text{NO}][\text{O}_2]^2$  (C)  $\text{rate} = k[\text{NO}]^2[\text{O}_2]$   
(D)  $\text{rate} = k[\text{NO}]^2[\text{O}_2]^2$  (E)  $\text{rate} = k[\text{NO}]/[\text{O}_2]$

Ionization Energies for element X (kJ mol <sup>-1</sup> )				
First	Second	Third	Fourth	Five
580	1815	2740	11600	14800

20. The ionization energies for element X are listed in the table above. On the basis of the data, element X is most likely to be

- (A) Na (B) Mg (C) Al (D) Si (E) P

21. Of the following molecules, which has the largest dipole moment?

- (A) CO (B) CO<sub>2</sub> (C) O<sub>2</sub> (D) HF (E) F<sub>2</sub>

22. What is the H<sup>+</sup>(aq) concentration in 0.05 M HCN (aq)? (The K<sub>a</sub> for HCN is  $5.0 \times 10^{-10}$ )

- (A)  $2.5 \times 10^{-11}$  (B)  $2.5 \times 10^{-10}$  (C)  $5.0 \times 10^{-10}$  (D)  $5.0 \times 10^{-6}$  (E)  $5.0 \times 10^{-4}$

(本試題共 5 頁, 第 4 頁)

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3. 試題隨卷繳回。

23. Which of the following occurs when excess concentrated  $\text{NH}_3(\text{aq})$  is mixed thoroughly with  $0.1 \text{ M Cu}(\text{NO}_3)_2(\text{aq})$ ?

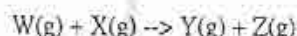
- (A) A dark red precipitate forms and settles out.
- (B) Separate layers of immiscible liquids form with a blue layer on top.
- (C) The color of the solution turns from light blue to dark blue.
- (D) Bubbles of ammonia gas form.
- (E) The pH of the solution decreases.

24. In the periodic table, as the atomic number increases from 11 to 17, what happens to the atomic radius?

- (A) It remains constant. (B) It increases only. (C) It increases, then decreases. (D) It decreases only. (E) It decreases, then increases.

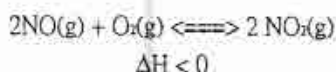
25. Under which of the following sets of conditions could the most  $\text{O}_2(\text{g})$  be dissolved in  $\text{H}_2\text{O}(\text{l})$ ?

	Pressure of $\text{O}_2(\text{g})$ Above $\text{H}_2\text{O}(\text{l})$ (atm)	Temperature of $\text{H}_2\text{O}(\text{l})$ (°C)
A)	5.0	80
B)	5.0	20
C)	1.0	80
D)	1.0	20
E)	0.5	20



26. Gases W and X react in a closed, rigid vessel to form gases Y and Z according to the equation above. The initial pressure of W(g) is 1.20 atm and that of X(g) is 1.60 atm. No Y(g) or Z(g) is initially present. The experiment is carried out at constant temperature. What is the partial pressure of Z(g) when the partial pressure of W(g) has decreased to 1.0 atm?

- (A) 0.20 atm (B) 0.40 atm (C) 1.0 atm (D) 1.2 atm (E) 1.4 atm



27. Which of the following changes alone would cause a decrease in the value of  $K_{\text{eq}}$  for the reaction represented above?

- (A) Decreasing the temperature (B) Increasing the temperature (C) Decreasing the volume of the reaction vessel (D) Increasing the volume of the reaction vessel (E) Adding a catalyst

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(本試題共 5 頁, 第 5 頁)

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28. According to the information above, what is the standard reduction potential for the half-reaction  $\text{M}^{3+}(\text{aq}) + 3 \text{e}^- \rightarrow \text{M(s)}$ ?

- (A) -1.66 V (B) -0.06 V (C) 0.06 V (D) 1.66 V (E) 3.26 V



29. For the reaction of ethylene represented above,  $\Delta H$  is -1,323 kJ. What is the value of  $\Delta H$  if the combustion produced liquid water  $\text{H}_2\text{O(l)}$ , rather than water vapor  $\text{H}_2\text{O(g)}$ ? ( $\Delta H$  for the phase change  $\text{H}_2\text{O(g)} \rightarrow \text{H}_2\text{O(l)}$  is -44 kJ  $\text{mol}^{-1}$ .)

- (A) -1,235 kJ (B) -1,279 kJ (C) -1,323 kJ (D) -1,367 kJ (E) -1,411 kJ

30. Equal numbers of moles of  $\text{He(g)}$ ,  $\text{Ar(g)}$ , and  $\text{Ne(g)}$  are placed in a glass vessel at room temperature. If the vessel has a pinhole-sized leak, which of the following will be true regarding the relative values of the partial pressures of the gases remaining in the vessel after some of the gas mixture has effused?

- (A)  $P_{\text{He}} < P_{\text{Ne}} < P_{\text{Ar}}$  (B)  $P_{\text{He}} < P_{\text{Ar}} < P_{\text{Ne}}$  (C)  $P_{\text{Ne}} < P_{\text{Ar}} < P_{\text{He}}$  (D)  $P_{\text{Ar}} < P_{\text{He}} < P_{\text{Ne}}$  (E)  $P_{\text{He}} = P_{\text{Ar}} = P_{\text{Ne}}$

31. When solid ammonium chloride,  $\text{NH}_4\text{Cl(s)}$  is added to water at 25 °C, it dissolves and the temperature of the solution decreases. Which of the following is true for the values of  $\Delta H$  and  $\Delta S$  for the dissolving process?

- | $\Delta H$  | $\Delta S$    |
|-------------|---------------|
| A) Positive | Positive      |
| B) Positive | Negative      |
| C) Positive | Equal to zero |
| D) Negative | Positive      |
| E) Negative | Negative      |