

科目：普通化學

適用：應化系二

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. 限用藍、黑色筆作答；試題須隨卷繳回。

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第 1 頁

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## 一、單選題 (80%，每題 4 分)

1. Which compound has the smallest molar mass?  
[A]  $\text{CO}_2$  [B]  $\text{CHCl}_3$  [C]  $\text{C}_2\text{H}_6$  [D]  $\text{C}_2\text{H}_4\text{O}$  [E] none of these
2. Which element does not belong to the family or classification indicated?  
[A] Ar, noble gas [B] Bi, transition metal [C] Br, halogen [D] K, alkali metal
3. What is the subscript of oxygen in the formula of aluminum phosphate?  
[A] 1 [B] 2 [C] 3 [D] 4 [E] 5
4. The following reactions:  

$$\text{Pb}^{2+} + 2\text{I}^- \rightarrow \text{PbI}_2$$

$$2\text{Ce}^{4+} + 2\text{I}^- \rightarrow \text{I}_2 + 2\text{Ce}^{3+}$$

$$\text{HOAc} + \text{NH}_3 \rightarrow \text{NH}_4^+ + \text{OAc}^-$$
 are examples of  
 [A] acid-base reactions. [B] precipitation, acid-base, and redox reactions, respectively  
 [C] unbalanced reactions. [D] redox, acid-base, and precipitation reactions, respectively.  
 [E] precipitation, redox, and acid-base reactions, respectively.
5. Given the equation  $A + 3B \rightarrow C + D$ , you react 1 mole of  $A$  with 2 moles of  $B$ . Which of the following is true?  
 [A]  $A$  is the limiting reactant because 1  $A$  molecules react with 3  $B$  molecule.  
 [B]  $A$  is the limiting reactant because you have fewer moles of  $A$  than  $B$ .  
 [C]  $B$  is the limiting reactant because you need 3 moles of  $A$  and have 2.  
 [D]  $B$  is the limiting reactant because of its higher molar mass.  
 [E] Neither reactant is limiting.
6. When 0.2 M sodium hydroxide and 0.2 M calcium nitrate are mixed, a precipitate is formed. What is the net ionic equation for the formation of this precipitate?  
 [A]  $\text{Ca}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$  [B]  $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$   
 [C]  $\text{Ca}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow \text{Ca}(\text{NO}_3)_2(\text{s})$  [D]  $\text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NaOH}(\text{s})$
7. Four identical 1.0-L flasks contain the gases He,  $\text{Cl}_2$ ,  $\text{CH}_4$ , and  $\text{NH}_3$ , each at  $0^\circ\text{C}$  and 1 atm pressure. Which gas sample has the greatest number of molecules?  
 [A]  $\text{CH}_4$  [B]  $\text{Cl}_2$  [C] He [D]  $\text{NH}_3$  [E] all of these

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8. A solution of two liquids, A and B, shows negative deviation from Raoult's law. This means that
- [A] molecules of A interact strongly with other A-type molecules.
  - [B] molecules of A interact weakly, if at all, with B molecules.
  - [C] molecules of A interact more strongly with B than with A or and more strongly than B with B.
  - [D] the molecules of A hinder the strong interaction between B molecules.
  - [E] none of these.
9. The value of the equilibrium constant  $K$  is dependent on:
- I. the concentration of the reactants.
  - II. the final concentrations of the products.
  - III. the temperature of the system.
  - IV. the nature of the reactants and products.
- [A] III and IV only.
  - [B] II and III only.
  - [C] I and II only.
  - [D] three of these.
  - [E] none of these.
10. Consider two separate solutions of equal concentration. The first solution contains sodium hydroxide, and the second solution contains barium hydroxide. Which solution has the higher pH?
- [A] The barium hydroxide solution.
  - [B] We need to know the volumes to answer this question.
  - [C] The sodium hydroxide solution.
  - [D] The pH's of the two solutions are equal.
  - [E] We need to know the concentrations to answer this question.
11. Consider the process  $A(l) \rightleftharpoons A(s)$ . An increase in temperature favors which direction?
- [A] to the left.
  - [B] to the right.
  - [C] neither.
  - [D] More information is needed.
12. Which of the following statements is true?
- [A] An excited atom can return to its ground state by absorbing electromagnetic radiation.
  - [B] The energy of an atom is increased when electromagnetic radiation is emitted from it.
  - [C] The energy of electromagnetic radiation increases as its frequency decreases.
  - [D] An electron in the  $n = 4$  state in the hydrogen atom can go to the  $n = 2$  state by emitting electromagnetic radiation at the appropriate frequency.
13. Which of the following compounds is the most soluble (in moles per liter)?
- [A]  $\text{AgBr}$  ( $K_{sp} 5.0 \times 10^{-13}$ )
  - [B]  $\text{BaCO}_3$  ( $K_{sp} 1.6 \times 10^{-9}$ )
  - [C]  $\text{BaSO}_4$  ( $K_{sp} 1.5 \times 10^{-9}$ )
  - [D]  $\text{CoS}$  ( $K_{sp} 5.0 \times 10^{-22}$ )
  - [E]  $\text{PbSO}_4$  ( $K_{sp} 1.3 \times 10^{-8}$ )
14. Place the elements C, N, and O in order of increasing ionization energy.
- [A] O, N, C
  - [B] N, O, C
  - [C] C, N, O
  - [D] C, O, N
  - [E] none of these

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15. Which of the following statements is correct?
- [A] Atoms or molecules with an even number of electrons are diamagnetic.  
[B] Atoms or molecules with an odd number of electrons are paramagnetic.  
[C] Paramagnetism cannot be deduced from the Lewis structure of a molecule alone.  
[D] Paramagnetic molecules are attracted toward a magnetic field.  
[E]  $N_2$  molecules are diamagnetic.
16. Atoms having greatly differing electronegativities are expected to form
- [A] covalent bonds. [B] ionic bonds. [C] no bonds.  
[D] nonpolar covalent bonds. [E] polar covalent bonds.
17. The rate constant  $k$  is dependent on
- [A] the concentration of the product. [B] the concentration of the reactant.  
[C] the order of the reaction. [D] the temperature. [E] none of these.
18. Which one of the following is the strongest intermolecular force experienced by noble gases?
- [A] dipole-dipole interactions [B] hydrogen bonding [C] ionic bonding  
[D] London dispersion forces [E] none of these
19. A salt solution sits in an open beaker. Assuming constant temperature and pressure, the vapor pressure of the solution
- [A] decreases over time. [B] increases over time. [C] stays the same over time.  
[D] We need to know which salt is in the solution to answer this.  
[E] We need to know the temperature and pressure to answer this.
20. Which of the following has the largest radius?
- [A]  $F^-$  [B]  $Mg^{2+}$  [C]  $Na^+$  [D] Ne [E]  $O^{2-}$

## 二、簡答題 (20%)

1. Consider the following reaction:  $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$   $\Delta H = -198.2 \text{ kJ}$
- (A) (2%) Is the reaction endothermic or exothermic as written?  
(B) (2%) Which direction will the equilibrium shift if helium is added into the reaction chamber?  
(C) (2%) Which direction will the equilibrium shift if the volume of the reaction chamber decreases?



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2. For  $\text{CO}_3^{2-}$  ion:

- (A) (2%) Draw a Lewis structure.
- (B) (2%) Label the angles of the C-O bonds.
- (C) (2%) What is the shape of the molecule around the central atom?
- (D) (2%) What is the hybridization of the central atom?
- (E) (3%) Compare the bond length of the C-O bonds in  $\text{CO}_3^{2-}$  ion and  $\text{CO}_2$  molecule. Why?
- (F) (3%) How many  $\sigma$  bonds and  $\pi$  bonds in  $\text{CO}_3^{2-}$  ion?

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