

# 國立成功大學

## 115學年度碩士班招生考試試題

編 號：42

系 所：地球科學系

科 目：普通化學

日 期：0204

節 次：第 2 節

注 意：1. 不可使用計算機  
2. 請於答案卷(卡)作答，於  
試題上作答，不予計分。

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一、選擇題：(75 %; 每題 3 分，答錯不倒扣。)

- Which of the following statements is(are) true?  
I. O and F have the same number of neutrons.  
II. C and N are isotopes of each other because their mass numbers are the same.  
III.  $O^{2-}$  has the same number of electrons as Ne.  
(A) I only ; (B) II only ; (C) III only ; (D) I and II only ; (E) I and III only.
- Which of the following is *not* the correct chemical formula for the compound named?  
(A)  $Al(OH)_2$  aluminum hydroxide ; (B)  $LiCN$  lithium cyanide;  
(C)  $Fe_2O_3$  iron(III) oxide ; (D)  $ZnS$  zinc sulfide ;  
(E)  $Mg(C_2H_3O_2)_2$  magnesium acetate.
- Phosphorus has the molecular formula  $P_4$  and sulfur has the molecular formula  $S_8$ . How many grams of phosphorus contain the same number of molecules as 6.40 g of sulfur?  
(S: 32 ; P: 31)  
(A) 3.20 g ; (B) 3.10 g ; (C) 6.20 g ; (D) 6.40 g ; (E) none of these.
- Consider the unbalanced equation:  $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$ .  
For every 1.0 mol of  $C_4H_{10}$ , \_\_\_ mol of  $O_2$  is required.  
(A) 1.0 ; (B) 13.0 ; (C) 4.0 ; (D) 6.5 ; (E) 5.5.
- In the reaction:  $2A + B \rightarrow 3C + D$ . When 3.0 mol A and 2.0 mol B react to form 4.0 mol C. What is the percent yield of this reaction?  
(A) 50% ; (B) 67% ; (C) 75% ; (D) 80% ; (E) 89%.
- To calculate the concentration in molarity of a salt solution, you need to know.  
(A) the mass of the salt added to the solution and the mass of water added to the solution.  
(B) the mass of the salt added to the solution and the total volume of the solution.  
(C) the mass of the salt added, the molar mass of the salt, and the total volume of the solution.  
(D) the molar mass of the salt and the total volume of the solution.  
(E) the mass of the salt added, the molar mass of the salt, the mass of solvent added, and the molar mass of the solvent.
- Which of the following is *not* an oxidation-reduction reaction?  
(A) A precipitation reaction ; (B) A reaction in which a metal reacts with a nonmetal ; (C) A combustion reaction ;  
(D) A metal reacting with an acid ;  
(E) All of these are oxidation-reduction reactions.

8. Four identical 1.0-L flasks contain the gases He, Cl<sub>2</sub>, CH<sub>4</sub>, and NH<sub>3</sub>, each at 0°C and 1.0 atm pressure. Which gas has the highest density?  
(A) He ; (B) Cl<sub>2</sub> ; (C) CH<sub>4</sub> ; (D) NH<sub>3</sub> ; (E) All the gases have the same density.
9. Under which of the following conditions does a gas behave most ideally?  
(A) STP ; (B)  $P = 1.0 \text{ atm}$ ,  $T = 100.0^\circ\text{C}$  ; (C)  $P = 0.50 \text{ atm}$ ,  $T = 0.0^\circ\text{C}$  ;  
(D)  $P = 0.50 \text{ atm}$ ,  $T = 100.0^\circ\text{C}$  ; (E)  $P = 2.0 \text{ atm}$ ,  $T = -100.0^\circ\text{C}$
10. When the substances in the equation below are at equilibrium at pressure  $P$  and temperature  $T$ , how can the equilibrium be shifted to favor the products?  
$$\text{CuO}(s) + \text{H}_2(g) \rightleftharpoons \text{Cu}(s) + \text{H}_2\text{O}(g) \quad ; \Delta H = -20.0 \text{ kJ}$$
  
(A) Add a catalyst ; (B) Increase the pressure by adding an inert gas such as nitrogen;  
(C) Increase the pressure by means of a moving piston at constant temperature;  
(D) Allow some gas to escape at constant pressure and temperature ;  
(E) Decrease the temperature.
11. At a particular temperature, the ion-product constant of water,  $K_w$ , is  $3.6 \times 10^{-15}$ . What is the pH of pure water at this temperature?  
(A) 7.00 ; (B) 6.78 ; (C) 6.22 ; (D) 7.22 ; (E) 6.66
12. HOAc:  $K_a = 1.8 \times 10^{-5}$ ; H<sub>2</sub>CO<sub>3</sub>:  $K_{a1} = 4.3 \times 10^{-7}$ ,  $K_{a2} = 5.6 \times 10^{-11}$   
Which of the following 0.01  $M$  solutions has the highest pH?  
(A) HOAc ; (B) NaOAc ; (C) H<sub>2</sub>CO<sub>3</sub> ; (D) NaHCO<sub>3</sub> ; (E) Na<sub>2</sub>CO<sub>3</sub>
13. Which is the closest pH value of a  $2.0 \times 10^{-8} M$  solution of HNO<sub>3</sub>.  
(A) 7.70 ; (B) 7.20 ; (C) 6.96 ; (D) 6.05 ; (E) 3.95.
14. For ammonia,  $K_b$  is  $1.8 \times 10^{-5}$ . To make a buffered solution with pH 10.0, the ratio of NH<sub>4</sub>Cl to NH<sub>3</sub> must be  
(A) 5.5 ; (B) 0.18 ; (C) 1.8 ; (D) 18 ; (E) 0.55
15. When 0.140 mol of NH<sub>3</sub> is reacted with excess HCl at 1.0 atm, 7.0 kJ of energy is released as heat. What is  $\Delta H$  for this reaction per mole of NH<sub>3</sub> consumed?  
(A) -50.0 kJ ; (B) -25.0 kJ ; (C) 50.0 kJ ; (D) 25.0 kJ ; (E) -9.8 kJ.
16. For an electron in a one-dimensional box, what is the minimum energy to excite the electron from the ground state?  
(A)  $\frac{\hbar^2}{8 \text{ mL}^2}$  ; (B)  $\frac{2\hbar^2}{8 \text{ mL}^2}$  ; (C)  $\frac{3\hbar^2}{8 \text{ mL}^2}$  ; (D)  $\frac{4\hbar^2}{8 \text{ mL}^2}$  ; (E)  $\frac{5\hbar^2}{8 \text{ mL}^2}$

17. Which of the following combinations of quantum numbers is *not* allowed?

(Combinations are listed as follows:  $n, l, m_l, m_s$ .)

- (A) 1    1    0    1/2 ; (B) 4    0    0    -1/2 ;  
 (C) 3    1    0    1/2 ; (D) 5    3    0    -1/2 ;  
 (E) 3    1    0    -1/2

18. Which of the following bonds would be the most polar without being considered ionic?

- (A) Mg-O ; (B) C-O ; (C) O-O ; (D) N-O ; (E) Si-O

19. The bond angles about the carbon atom in the formaldehyde molecule,  $\text{H}_2\text{C}=\text{O}$ , are about?

- (A)  $60^\circ$  ; (B)  $90^\circ$  ; (C)  $109^\circ$  ; (D)  $120^\circ$  ; (E)  $180^\circ$ .

20. The following data were obtained for the reaction of NO with  $\text{O}_2$ . Concentrations are in molecules/ $\text{cm}^3$  and rates are in molecules/ $\text{cm}^3 \cdot \text{s}$ .

$[\text{NO}]_0$	$[\text{O}_2]_0$	Initial Rate
$1 \times 10^{18}$	$1 \times 10^{18}$	$2.0 \times 10^{16}$
$2 \times 10^{18}$	$1 \times 10^{18}$	$8.0 \times 10^{16}$
$3 \times 10^{18}$	$1 \times 10^{18}$	$18.0 \times 10^{16}$
$1 \times 10^{18}$	$2 \times 10^{18}$	$4.0 \times 10^{16}$

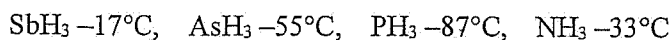
Which of the following is the correct rate law?

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

21. The decomposition of  $\text{N}_2\text{O}_5(\text{g})$  to  $\text{NO}_2(\text{g})$  and  $\text{O}_2(\text{g})$  has a rate constant  $k = 3.4 \times 10^{-5} \text{ s}^{-1}$  at  $25^\circ\text{C}$  and  $[\text{N}_2\text{O}_5(\text{g})] = 1.0 \text{ M}$ . What is the half-life for the reaction described? ( $\ln 2 = 0.693$ )

- (A)  $5.9 \times 10^5 \text{ s}$  ; (B)  $2.0 \times 10^4 \text{ s}$  ; (C)  $2.4 \times 10^{-5} \text{ s}$  ; (D)  $7.4 \times 10^2 \text{ s}$  ; (E)  $3.1 \times 10^4 \text{ s}$

22. The elements of Group 5A, the nitrogen family, form compounds with hydrogen that have the boiling points listed below.



The first three elements illustrate a trend where the boiling point decreases as the mass decreases; however, ammonia ( $\text{NH}_3$ ) does not follow the trend because of

- (A) dipole-dipole attraction ; (B) metallic bonding ; (C) hydrogen bonding ;  
 (D) London dispersion forces ; (E) ionic bonding.

23. A liquid-liquid solution is called an ideal solution if

- I. it obeys  $PV = nRT$ . ; II. it obeys Raoult's law.  
 III. solute-solute, solvent-solvent, and solute-solvent interactions are very similar.  
 IV. solute-solute, solvent-solvent, and solute-solvent interactions are quite different.

- (A) I, II, III ; (B) I, II, IV ; (C) I, II ; (D) II, III ; (E) II, IV.

24. For the process  $\text{Co}(\text{NH}_3)_5\text{Cl}^{2+} + \text{Cl}^- \rightarrow \text{Co}(\text{NH}_3)_4\text{Cl}_2^+ + \text{NH}_3$ , what would be the ratio of *cis* to *trans* isomers in the product?  
 (A) 1 : 1 ; (B) 1 : 2 ; (C) 1 : 4 ; (D) 2 : 1 ; (E) 4 : 1.
25. In which of the following lists do all members have a C=O bond?  
 (A) ester, aldehyde, ketone ; (B) any alcohol, ether, ester ; (C) secondary alcohol, ketone, aldehyde;  
 (D) ether, ketone, aldehyde ; (E) carboxylic acid, ether, tertiary alcohol.

二、問答與計算題 (25 % ; 計算與問答題需寫過程否則不予計分)

1. (a) Use the Second Law of Thermodynamics to predict the direction of the heat flow  
 (A  $\rightarrow$  B, no heat flow or B  $\rightarrow$  A), if  $T_A > T_B$ , **why?** (5 %)

A ( $T_A$ )	B ( $T_B$ )
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- (b). What values are of the  $\Delta G$  and  $\Delta S_{\text{univ}}$  for a spontaneous process at constant temperature and pressure? (4 %)
2. Use an MO energy-level diagram to give the **electron configuration**, **bond order** and **magnetism** for each of the species:  $\text{O}_2^+$ ,  $\text{O}_2$ , and  $\text{O}_2^-$  (9 %).
3. (a). Calculate the  $\varepsilon^\circ_{\text{cell}}$  of the galvanic cell (電池) based on the following half-reactions under standard conditions.  
 (4 %)
- $$\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu} \quad \varepsilon^\circ = 0.34 \text{ V}$$
- $$\text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+} \quad \varepsilon^\circ = 0.77 \text{ V}$$
- (b). Calculate the maximum electric energy released from the above galvanic cell when 3.0 mole of electrons were transferred (1 mol electrons  $\approx$  100,000 C). (3 %)