

國立臺北科技大學 103 學年度碩士班招生考試

系所組別：3620 化學工程與生物科技系生化與生醫工程碩士班乙組

第二節 普通化學 試題

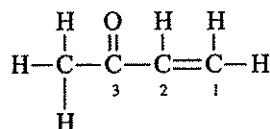
第一頁 共三頁

注意事項：

1. 本試題共 40 題，配分共 100 分。
2. 請依編號作答，不必抄題。
3. 計算時，請選擇依計算數值最接近之選項作答。
4. 全部答案，均須寫在答案卷之答案欄內，否則不予計分。

1. Order the intermolecular forces (dipole-dipole, London dispersion, ionic, and hydrogen-bonding) from weakest to strongest.
(A) dipole-dipole, London dispersion, ionic, and hydrogen-bonding
(B) London dispersion, dipole-dipole, hydrogen-bonding, and ionic
(C) hydrogen-bonding, dipole-dipole, London dispersion, and ionic
(D) dipole-dipole, ionic, London dispersion, and hydrogen-bonding
(E) London dispersion, ionic, dipole-dipole, and hydrogen-bonding
2. In which of the following groups of substances would dispersion forces be the only *significant* factors in determining boiling points? (I. Cl_2 ; II. HF ; III. Ne ; IV. KNO_2 ; V. CCl_4)
(A) I, III, V (B) I, II, III (C) II, IV (D) II, V (E) III, IV, V
3. A material is made from Al, Ga, and As. The mole fraction of each element is 0.25, 0.26, and 0.49, respectively. This material would be
(A) a metallic conductor because Al is present (B) an insulator
(C) a p-type semiconductor (D) an n-type semiconductor (E) none of the above
4. Which of the following complexes shows geometrical isomerism?
(A) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ (B) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ (C) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
(D) $\text{K}[\text{Co}(\text{NH}_3)_2\text{Cl}_4]$ (E) none of these

5. You are given the following boiling point data. Which one of the liquids would you expect to have the highest vapor pressure at room temperature? (A) water, H_2O , 100°C .
 (B) methanol, CH_3OH , 64.96°C (C) ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, 78.5°C
 (D) diethyl ether, $\text{CH}_3\text{OH}_2\text{-O-CH}_2\text{CH}_3$, 34.5°C (E) ethylene glycol, $\text{HO-CH}_2\text{-CH}_2\text{-OH}$, 198°C
6. Name the compound on the right side:
- (A) 2-chloro-3-chloro-cis-2-butene (B) 2,3-dichloro-cis-2-butene
 (C) 2,3-dichloro-trans-2-butene (D) 1-chloro-1-methyl-2-chloro-propene
 (E) 2,3-dichloro-1-methyl-propene
7. The triple point of iodine is at 90 torr and 115°C . This means that liquid I_2
 (A) is more dense than $\text{I}_2(\text{s})$
 (B) cannot exist above 115°C
 (C) cannot exist at 1 atmosphere pressure
 (D) cannot have a vapor pressure less than 90 torr
 (E) can exist at pressure of 10 torr
8. Gaseous chlorine is held in two separate containers at identical temperature and pressure. The volume of container 1 is 1.30 L, and it contains 6.70 mol of the gas. The volume of container 2 is 2.32 L. How many moles of the gas are in container 2?
 (A) 12.0, (B) 20.2, (C) 0.450, (D) 3.75, (E) none of these
9. A sample of oxygen gas has a volume of 7.15 L at 27°C and 800.0 torr. How many oxygen molecules does it contain?
 (A) 1.84×10^{23} , (B) 1.40×10^{26} , (C) 2.05×10^{24} , (D) 1.97×10^{24} , (E) none of these
10. Given that ΔH_{vap} is 64.60 kJ/mol, and the boiling point is 83.4°C , 1 atm, if one mole of this substance is vaporized at 1 atm, calculate ΔS (in J/K mol).
 (A) -181.2, (B) 181.2, (C) 775.2, (D) -775.2, (E) 0
11. Which of the following species has a trigonal bipyramid structure?
 (A) NH_3 , (B) IF_5 , (C) I_3^- , (D) PCl_5 , (E) none of these
12. Consider the following Lewis structure:



Which statement about the molecule is **false**?

- (A) There are 10 sigma and 2 π bonds. (B) C-2 is sp^2 hybridized with bond angles of 120° .
 (C) Oxygen is sp^3 hybridized. (D) This molecule contains 28 valence electrons.
 (E) There are some H-C-H bond angles of about 109° in the molecule.

注意：背面尚有試題

13. Which of the following ionic compounds has the largest lattice energy?
(A) SrO, (B) BeO, (C) KI, (D) CsBr, (E) BaS
14. Using the following bond energies (kJ/mol): C≡C, 839; C-H, 413; O=O, 495; C=O, 799; O-H, 467. Estimate the heat (kJ) of combustion for one mole of acetylene:
 $C_2H_2(g) + \frac{5}{2}O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$
(A) 1228, (B) -1228, (C) -447, (D) +447, (E) +365
15. How many oxygen atoms are there in 8.77 ng of $Ca_3(PO_4)_2$? (Ca = 40.08, P = 30.97, O = 16.00)
(A) 1.70×10^{13} , (B) 6.81×10^{13} , (C) 4.23×10^{16} , (D) 1.36×10^{23} , (E) 1.36×10^{14}
16. Which of the following names is **incorrect**?
(A) iodine trichloride, ICl_3 (B) phosphorus pentoxide, P_2O_5 (C) ammonia, NH_3
(D) sulfur hexafluoride, SF_6 (E) All of the above pairs are correct.
17. All of the following are in aqueous solution. Which is incorrectly named?
(A) $HC_2H_3O_2$, acetic acid (B) HBr, bromic acid (C) H_2SO_3 , sulfurous acid
(D) HNO_2 , nitrous acid (E) $HClO_3$, chloric acid
18. Which of the following statements best describes the Heisenberg uncertainty principle?
(A) The exact position of an electron is always uncertain.
(B) The velocity of a particle can only be estimated.
(C) It is impossible to accurately know both the exact location and momentum of a particle.
(D) The location and momentum of a macroscopic object are not known with certainty.
(E) The location and momentum of a particle can be determined accurately, but not the identity of the particle.
19. How many electrons can be described by the quantum numbers: $n = 2, l = 2, m_l = 1$?
(A) 0, (B) 2, (C) 6, (D) 10, (E) 14
20. The small, but important, energy differences between 3s, 3p, and 3d orbitals are due mainly to
(A) the number of electrons they can hold (B) their principal quantum number
(C) the Heisenberg uncertainty principle (D) the penetration effect (E) Hund's rule
21. Mendeleev is given the most credit for the concept of a periodic table of the elements because:
(A) He had the longest history of research in elemental properties.
(B) He emphasized its usefulness in predicting the existence and properties of unknown elements.
(C) His representation of the table was the most understandable.
(D) His periodic table was arranged in octaves.
(E) He grouped elements into triads of similar properties.

22. Which is the electron configuration for the barium atom?
(A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$, (B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$, (C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$,
(D) $[\text{Xe}]6s^2$, (E) none of these
23. An element has the electron configuration $[\text{Kr}]5s^2 4d^{10} 5p^2$. Which of the following is the element?
(A) nonmetal, (B) transition element, (C) metal, (D) lanthanide, (E) actinide
24. You heat 3.873 g of a mixture of Fe_3O_4 and FeO to form 4.128 g Fe_2O_3 . Which of the following is the mass percent (%) of FeO originally in the mixture? ($\text{Fe} = 55.85$, $\text{O} = 16.00$)
(A) 93.8, (B) 42.0, (C) 58.0, (D) 29.0, (E) none of these
25. Phosphoric acid, H_3PO_4 , is a triprotic acid. What is the total number of moles of H^+ available for reaction in 4.50 L of 0.450 M H_3PO_4 ?
(A) 0.105, (B) 1.305, (C) 0.675, (D) 3.005, (E) 6.075
26. Given the equation $3\text{A} + \text{B} \rightarrow \text{C} + \text{D}$, you react 2 moles of A with 1 mole of B. Which of the following is true? (A) A is the limiting reactant because of its higher molar mass.
(B) A is the limiting reactant because you need 3 moles of A and have 2.
(C) B is the limiting reactant because you have fewer moles of B than A.
(D) B is the limiting reactant because 3 A molecules react with 1 B molecule.
(E) Neither reactant is limiting.
27. If all of the chloride in a 3.277-g sample of an unknown metal chloride is precipitated as AgCl with 70.90 mL of 0.2010 M AgNO_3 , what is the percentage of chloride in the sample?
($\text{Ag} = 107.9$, $\text{Cl} = 35.45$)
(A) 50.52, (B) 15.42, (C) 1.425, (D) 6.487, (E) none of the above
28. The solubility of O_2 in water is 0.590 g/L at an oxygen pressure of around 15.4 atm. What is the Henry's law constant for O_2 (in units of $\text{mol/L}\cdot\text{atm}$)? ($\text{O} = 16.00$)
(A) 1.20×10^{-3} , (B) 3.83×10^{-2} , (C) 2.84×10^{-1} , (D) 8.35×10^2 , (E) none of these
29. Liquid A and liquid B form a solution that behaves ideally according to Raoult's law. The vapor pressures of the pure A and B are 208 torr and 135 torr, respectively. Determine the vapor pressure (torr) over the solution if 1.28 moles of liquid A is added to 5.30 moles of liquid B.
(A) 149, (B) 185, (C) 194, (D) 760, (E) 40.5
30. The rate expression for a particular reaction is $\text{rate} = k[\text{A}][\text{B}]^2$. If the initial concentration of B is increased from 0.1 M to 0.3 M, the initial rate will increase by which of the following factors?
(A) 2, (B) 6, (C) 12, (D) 3, (E) 9

31. A certain first-order reaction has a half-life of 20.0 minutes. How much time (minutes) is required for this reaction to be 75% complete?
 (A) 12.04, (B) 20.02, (C) 28.08, (D) 39.94, (E) 60.02
32. For the second-order reaction $\text{NO}(\text{g}) + \text{O}_3(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{O}_2(\text{g})$, the rate constant has been measured to be $1.08 \times 10^7 \text{ M}^{-1} \text{ s}^{-1}$ at 298 K and the activation energy has been measured to be 11.4 kJ/mol over the temperature range 195 K to 304 K. What is the rate constant ($\text{M}^{-1} \text{ s}^{-1}$) at 259 K? ($R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$)
 (A) 1.08×10^7 , (B) 1.08×10^9 , (C) 5.40×10^6 , (D) 2.16×10^7 , (E) 9.51×10^5
33. For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container. $\text{A}(\text{g}) + 2\text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g})$. At equilibrium, the concentration of A is 0.303 mol/L. What is the concentration (mol/L) of B at equilibrium?
 (A) 0.303, (B) 0.439, (C) 0.500, (D) 0.606, (E) none of these
34. Consider the gaseous reaction $\text{CO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{COCl}_2(\text{g})$. What is the expression for K_p in terms of K_c ? (A) $K_c(RT)$, (B) $K_c/(RT)$, (C) $K_c(RT)^2$, (D) $K_c/(RT)^2$, (E) $1/K_c(RT)$
35. The equilibrium constants (K_a) for HCN and HF in H_2O at 25°C are 6.2×10^{-10} and 7.2×10^{-4} , respectively. Which one is the correct relative order of base strengths? (A) $\text{F}^- > \text{H}_2\text{O} > \text{CN}^-$, (B) $\text{H}_2\text{O} > \text{F}^- > \text{CN}^-$, (C) $\text{CN}^- > \text{F}^- > \text{H}_2\text{O}$, (D) $\text{F}^- > \text{CN}^- > \text{H}_2\text{O}$, (E) none of these
36. For weak acid, HX, $K_a = 1.7 \times 10^{-6}$. Calculate the pH of a 0.16 M solution of HX.
 (A) 0.80, (B) 3.28, (C) 6.57, (D) 10.72, (E) none of these
37. The K_{sp} of PbSO_4 is 1.3×10^{-8} . Calculate the solubility (in mol/L) of PbSO_4 in a 0.0078 M solution of Na_2SO_4 . (A) 1.0×10^{-10} , (B) 2.8×10^{-12} , (C) 1.7×10^{-6} , (D) 1.3×10^{-8} , (E) 1.3×10^{-3}
38. How many moles of solid NaF would have to be added to 1.0 L of 1.70 M HF solution to achieve a buffer of pH 3.35? Assume there is no volume change. (K_a for HF = 7.2×10^{-4})
 (A) 2.7, (B) 0.35, (C) 0.95, (D) 1.0, (E) 1.6
39. What is ΔG° (in kJ/mol) for the following electrochemical equation? ($E^\circ_{\text{red}}(\text{Na}^+/\text{Na}) = -2.710 \text{ V}$; $E^\circ_{\text{red}}(\text{Sn}^{2+}/\text{Sn}) = -0.138 \text{ V}$; $2\text{Na}(\text{s}) + \text{Sn}^{2+}(\text{aq}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{Sn}(\text{s})$)
 (A) 496, (B) -248, (C) -496, (D) -993, (E) 993
40. Why is nitrogen not able to form molecules with five covalent bonds?
 (A) Because nitrogen can only form a trigonal bipyramidal shape when it bonds with other elements. (B) Because nitrogen has such a high ionization energy that having five covalent bonds is not possible. (C) Because nitrogen only exists as N_2 gas at room temperature. (D) Because of nitrogen's small size and lack of available d orbitals for electrons.
 (E) At least two of the above are correct.

