

# 國立高雄師範大學 104 學年度學士班轉學生招生考試試題

系所別：化學系、生物科技系二年級

科 目：普通化學

※注意：1.不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上，於本試題上作答者，不予計分。

2.限用藍色或黑色之鋼筆、原子筆作答，以鉛筆或其他顏色作答者不予計分。

1. Multiple choice (每題 2%，共 40%)

(1) You find a compound composed only of element X and hydrogen, and you know that it is 91.33% element X by mass. Each molecule has 2.67 times as many H atoms as X atoms. What is element X?

(A) C                      (B) Ne                      (C) Si                      (D) Cl                      (E) Cu

(2) For an electron in a 2.00-nm one-dimensional box, calculate the wavelength of electromagnetic radiation to excite the electron from the ground state to the level with  $n = 3$ .

(A) 1650 nm      (B) 13,200 nm      (C) 1470 nm      (D) 12,100 nm      (E) none of these

(3) Which of the following statements is *incorrect*?

- (A) Ionic bonding results from the transfer of electrons from one atom to another.
- (B) Dipole moments result from the unequal distribution of electrons in a molecule.
- (C) The electrons in a polar bond are found nearer to the more electronegative element.
- (D) A molecule with very polar bonds can be nonpolar.
- (E) Linear molecules cannot have a net dipole moment.

(4) Which of the following shows these molecules in order from most polar to least polar?

- (A)  $\text{CH}_4 > \text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$
- (B)  $\text{CH}_4 > \text{CF}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$
- (C)  $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CH}_4 = \text{CCl}_4$
- (D)  $\text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CH}_4 = \text{CCl}_4$
- (E)  $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2 > \text{CH}_4$

(5) Which of the following molecules has a *zero* dipole moment?

(A)  $\text{CO}_2$                       (B)  $\text{NCl}_3$                       (C)  $\text{H}_2\text{O}$                       (D)  $\text{SCl}_4$                       (E)  $\text{ICl}_3$

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- (6) For the hypothetical reactions 1 and 2,  $K_1 = 10^2$  and  $K_2 = 10^{-4}$ . What is the equilibrium constant for the reaction 3?
- $A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB(g)$
  - $2A_{2(g)} + C_{2(g)} \rightleftharpoons 2A_2C(g)$
  - $A_2C(g) + B_{2(g)} \rightleftharpoons 2AB(g) + (1/2)C_{2(g)}$
- (A)  $10^{-2}$       (B)  $10^4$       (C)  $10^6$       (D)  $10^2$       (E)  $10^{-4}$
- (7) One mole of an ideal gas is expanded from a volume of 3.00 L to a volume of 10.38 L against a constant external pressure of 1.08 atm. *Calculate the work.* (1 L atm = 101.3 J)
- (A)  $-7.48 \times 10^2$  J      (B)  $-7.97$  J  
(C)  $-8.07 \times 10^2$  J      (D)  $-0.0787$  J  
(E) 8.07 J
- (8) Which of the following are state functions?
- (A) work, heat      (B) work, heat, enthalpy, energy  
(C) enthalpy, energy      (D) work, heat, enthalpy  
(E) heat, enthalpy, energy
- (9) 1.00 mL of a  $3.50 \times 10^{-4}$  M solution of oleic acid is diluted with 9.00 mL of petroleum ether, forming solution A. 2.00 mL of solution A is diluted with 8.00 mL of petroleum ether, forming solution B. How many grams of oleic acid are in 5.00 mL of solution B? (molar mass for oleic acid = 282 g/mol)
- (A)  $4.94 \times 10^{-4}$  g      (B)  $7.00 \times 10^{-6}$  g  
(C)  $4.94 \times 10^{-5}$  g      (D)  $1.97 \times 10^{-6}$  g  
(E)  $9.87 \times 10^{-6}$  g
- (10) Calculate the pH of a solution that contains 3.25 M HCN ( $K_a = 6.2 \times 10^{-10}$ ), 1.00 M NaOH and 1.50 M NaCN.
- (A) 9.25      (B) 8.86      (C) 8.28      (D) 7.46      (E) none of these
- (11) Consider the dissociation reaction of the acid HF. Why is  $S$  negative?
- $$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$$
- (A) Each HF molecule produces two ions when it dissociates.  
(B) The ions are hydrated.  
(C) The reaction is expected to be exothermic, and  $\Delta S$  thus should be negative.  
(D) The reaction is expected to be endothermic, and thus  $\Delta S$  should be negative.  
(E) none of these.

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- (12) What is the oxidation state of Mn in  $\text{MnO}_2$ ?  
(A) +2            (B) +4            (C) +9            (D) -1            (E) +3
- (13) As a general pattern, electronegativity is inversely related to \_\_\_\_\_.  
(A) ionization energy            (B) atomic size  
(C) polarity of the atom            (D) the number of neutrons in the nucleus  
(E) two of these
- (14) The rate constant  $k$  is dependent on \_\_\_\_\_.  
(A) the concentration of the reactant  
(B) the concentration of the product  
(C) the temperature  
(D) the order of the reaction  
(E) none of these
- (15) Which one of the following is the strongest intermolecular force experienced by noble gases?  
(A) London dispersion forces            (B) dipole-dipole interactions  
(C) hydrogen bonding            (D) ionic bonding  
(E) polar covalent bonds.
- (16) The elements of Group 5A, the nitrogen family, form compounds with hydrogen that have the boiling points listed below.  
 $\text{SbH}_3$ :  $-17^\circ\text{C}$ ,  $\text{AsH}_3$ :  $-55^\circ\text{C}$ ,  $\text{PH}_3$ :  $-87^\circ\text{C}$ ,  $\text{NH}_3$ :  $-33^\circ\text{C}$   
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
- (17) The resistance of a liquid to an increase in its surface area is called \_\_\_\_\_.  
(A) capillary action            (B) surface tension  
(C) vapor pressure            (D) viscosity  
(E) none of these

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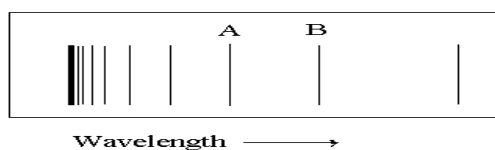
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- (18) How many protons, neutrons, and electrons does the atom  $^{31}\text{P}$  have?  
(A) 15 protons, 15 neutrons, 31 electrons  
(B) 16 protons, 16 neutrons, 15 electrons  
(C) 15 protons, 15 neutrons, 15 electrons  
(D) 16 protons, 15 neutrons, 16 electrons  
(E) 15 protons, 16 neutrons, 15 electrons
- (19) Mixing 40.0 mL of a 4.00 M sodium chloride solution with 20.0 mL of a 5.00 M calcium chloride solution results in a solution with a chloride ion concentration of \_\_\_\_.  
(A) 4.33 M      (B) 4.50 M      (C) 6.00 M      (D) 7.00 M      (E) none of these
- (20) You dissolve a 1.28-g sample of NaCl in a total volume of 125.0 mL of solution. Your lab partner has 1.50 M aqueous NaCl and wants to make a solution with the same concentration and volume as yours. How much of the solution does your lab partner need to use?  
(A) 1.83 mL      (B) 14.6 mL      (C) 107 mL      (D) 125 mL      (E) none of these
2. Give the shape and indicate the polarity for each of the following compounds: ( 10% )  
(a)  $\text{OCl}_2$ ,    (b)  $\text{SF}_4$ ,    (c)  $\text{CH}_4$ ,    (d)  $\text{SO}_2$ ,    (e)  $\text{IF}_6^+$
3. A chemist needs to prepare a solution buffered at pH 4.30 using one of the following acids (and its sodium salt):  
(a) chloroacetic acid ( $K_a = 1.35 \times 10^{-3}$ )      (b) propanoic acid ( $K_a = 1.3 \times 10^{-5}$ )  
(c) benzoic acid ( $K_a = 6.4 \times 10^{-5}$ )      (d) hypochlorous acid ( $K_a = 3.5 \times 10^{-8}$ )  
Calculate the ratio of  $[\text{HA}]/[\text{A}^-]$  required for each system to yield a pH of 4.30. Which system will work best? ( 10% )
4. Predict the sign of  $\Delta S^\circ$  for each of the following reactions. ( 8% )  
a. the thermal decomposition of solid calcium carbonate:  
$$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$$
  
b. the oxidation of  $\text{SO}_2$  in air:  
$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$$

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5. The figure below represents part of the emission spectrum for a one-electron ion in the gas phase. All the lines result from electronic transitions from excited states to the  $n = 3$  state. What electronic transitions correspond to lines A and B? (8%)



6. What evidence supports putting hydrogen in Group 1A of the periodic table? In some periodic tables hydrogen is listed separately from all of the groups. In what ways is hydrogen unlike a Group 1A element? (8%)
7. For elements 1–36, there are two exceptions to the filling order as predicted from the periodic table. Give the electron configurations for the two exceptions and indicate how many unpaired electrons are present. (8%)
8. Which of the following oxides are likely to be acidic, basic or amphoteric in aqueous solution: (8%)
- (a) MgO      (b) P<sub>2</sub>O<sub>5</sub>      (c) Al<sub>2</sub>O<sub>3</sub>      (d) BeO