

國立高雄大學九十八學年度轉學招生考試試題(轉 2 年級)

科目：普通化學  
考試時間：80 分鐘

系所：  
化學工程及材料工程學系  
本科原始成績：100 分

是否使用計算機：是

**Single choice questions (100 points total, 2.5 points each)**

1. What is the pH of a 0.0055 M HA (weak acid) solution that is 8.2% ionized?  
(A) 2.26, (B) 3.35, (C) 4.52, (D) 8.21, (E) 10.65
2. Which of the followings is *true* with regard to a 0.1 M solution of a weak acid HA?  
(A)  $[H^+] > [A^-]$ , (B)  $pH = 1.0$ , (C)  $[H^+] < [A^-]$ , (D)  $pH > 1.0$
3. Arrange the acids HOBr, HBrO<sub>3</sub>, and HBrO<sub>2</sub> in order of increasing acid strength.  
(A) HOBr < HBrO<sub>3</sub> < HBrO<sub>2</sub>, (B) HOBr < HBrO<sub>2</sub> < HBrO<sub>3</sub>, (C) HBrO<sub>2</sub> < HOBr < HBrO<sub>3</sub>, (D) HBrO<sub>3</sub> < HOBr < HBrO<sub>2</sub>, (E) HBrO<sub>3</sub> < HBrO<sub>2</sub> < HOBr
4. Which of the followings yields a basic solution when dissolved in water?  
(A) NO<sub>2</sub>, (B) P<sub>4</sub>O<sub>10</sub>, (C) K<sub>2</sub>O, (D) NaCl, (E) SO<sub>2</sub>
5. Which of the followings yields an acidic solution when dissolved in water?  
(A) NO<sub>2</sub>, (B) LiOH, (C) K<sub>2</sub>O, (D) NaCl, (E) Ca(OH)<sub>2</sub>
6. Which of these species is a Lewis acid, but *not* a Brønsted acid?  
(A) HCN, (B) CO<sub>3</sub><sup>2-</sup>, (C) OH<sup>-</sup>, (D) Cl<sup>-</sup>, (E) Al<sup>3+</sup>
7. An aqueous solution of KCl would be  
(A) neutral, (B) basic, (C) acidic.
8. What is the pH of a solution prepared by mixing 100. mL of 0.0500 M HCl with 300. mL of 0.500 M HF? [ $K_a$  (HF) =  $7.2 \times 10^{-4}$ ]  
(A) 1.47, (B) 1.90, (C) 1.30, (D) 1.63, (E) 2.82
9. Which of the followings is a buffer solution?  
(A) 0.40 M HCN and 0.10 M KCN, (B) 0.20 M CH<sub>3</sub>COOH, (C) 1.0 M HNO<sub>3</sub> and 1.0 M NaNO<sub>3</sub>, (D) 0.10 M KCN, (E) 0.50 M HCl and 0.10 M NaCl
10. Which of the following combinations cannot function as a buffer solution?  
(A) HCN and KCN, (B) NH<sub>3</sub> and (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, (C) HNO<sub>3</sub> and NaNO<sub>3</sub>, (D) HF and NaF, (E) HNO<sub>2</sub> and NaNO<sub>2</sub>
11. Assuming equal concentrations of conjugate base and acid, which of the following mixtures is suitable for making a buffer solution with an optimum pH of 9.2-9.3?  
(A) CH<sub>3</sub>COONa/CH<sub>3</sub>COOH ( $K_a = 1.8 \times 10^{-5}$ ), (B) NH<sub>3</sub>/NH<sub>4</sub>Cl ( $K_a = 5.6 \times 10^{-10}$ ), (C) NaOCl/HOCl ( $K_a = 3.2 \times 10^{-8}$ ), (D) NaNO<sub>2</sub>/HNO<sub>2</sub> ( $K_a = 4.5 \times 10^{-4}$ ), (E) NaCl/HCl
12. For which type of titration will the pH be basic at the equivalence point?  
(A) Strong acid vs. strong base, (B) Strong acid vs. weak base, (C) Weak acid vs. strong base, (D) all of the these, (E) none of these
13. Methyl red is a common acid-base indicator. It has a  $K_a$  equal to  $6.3 \times 10^{-6}$ . Its un-ionized form is red and its anionic form is yellow. What color would a methyl red solution have at pH = 7.8?

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- (A) green, (B) red, (C) blue, (D) yellow
14. In the titration of a weak acid HA with 0.100 M NaOH, the stoichiometric point is known to occur at a pH value of approximately 10. Which of the following indicator acids would be best to use to mark the end point of this titration?  
(A) Indicator A,  $K_a = 10^{-14}$ , (B) Indicator B,  $K_a = 10^{-11}$ , (C) Indicator C,  $K_a = 10^{-8}$ , (D) Indicator D,  $K_a = 10^{-6}$
15. The molar solubility of magnesium carbonate is  $1.8 \times 10^{-4}$  mol/L. What is  $K_{sp}$  for this compound?  
(A)  $1.8 \times 10^{-4}$ , (B)  $3.6 \times 10^{-4}$ , (C)  $1.3 \times 10^{-7}$ , (D)  $3.2 \times 10^{-8}$ , (E)  $2.8 \times 10^{-14}$
16. Which of the following would decrease the  $K_{sp}$  for  $PbI_2$ ?  
(A) Lowering the pH of the solution, (B) Adding a solution of  $Pb(NO_3)_2$ , (C) Adding a solution of KI, (D) None of these—the  $K_{sp}$  of a compound is constant at constant temperature.
17. Calculate the minimum concentration of  $Cr^{3+}$  that must be added to 0.095 M NaF in order to initiate a precipitate of chromium(III) fluoride. (For  $CrF_3$ ,  $K_{sp} = 6.6 \times 10^{-11}$ .)  
(A) 0.023 M, (B) 0.032 M, (C)  $7.7 \times 10^{-8}$  M, (D)  $2.9 \times 10^{-9}$  M, (E)  $6.9 \times 10^{-10}$  M
18. A negative sign for  $\Delta G$  indicates that, at constant T and P,  
(A) the reaction is exothermic, (B) the reaction is endothermic, (C) the reaction is fast, (D) the reaction is spontaneous, (E)  $\Delta S$  must be  $> 0$ .
19. Ozone ( $O_3$ ) in the atmosphere can react with nitric oxide (NO):  $O_3(g) + NO(g) \rightarrow NO_2(g) + O_2(g)$ . Calculate the  $\Delta G^\circ$  for this reaction at 25°C. ( $\Delta H^\circ = -199$  kJ/mol,  $\Delta S^\circ = -4.1$  J/K·mol)  
(A) 1020 kJ/mol, (B)  $-1.22 \times 10^3$  kJ/mol, (C)  $2.00 \times 10^3$  kJ/mol, (D)  $-1.42 \times 10^3$  kJ/mol, (E) -198 kJ/mol
20. For the reaction  $H_2(g) + S(s) \rightarrow H_2S(g)$ ,  $\Delta H^\circ = -20.2$  kJ/mol and  $\Delta S^\circ = +43.1$  J/K·mol. Which of these statements is *true*?  
(A) The reaction is only spontaneous at low temperatures, (B) The reaction is spontaneous at all temperatures, (C)  $\Delta G^\circ$  becomes less favorable as temperature increases, (D) The reaction is spontaneous only at high temperatures, (E) The reaction is at equilibrium at 25°C under standard conditions.
21. Given the galvanic cell,  $Pt(s) | H_2(g) | H^+(aq) || Ag^+(aq) | Ag(s)$ , what is the balanced overall (net) cell reaction?  
(A)  $2H^+(aq) + 2Ag^+(aq) \rightarrow H_2(g) + 2Ag(s)$ ; (B)  $H_2(g) + 2Ag(s) \rightarrow H^+(aq) + 2Ag^+(aq)$ ; (C)  $2H^+(aq) + 2Ag(s) \rightarrow H_2(g) + 2Ag^+(aq)$ ; (D)  $H_2(g) + Ag^+(aq) \rightarrow H^+(aq) + Ag(s)$ ; (E)  $H_2(g) + 2Ag^+(aq) \rightarrow 2H^+(aq) + 2Ag(s)$
22. A galvanic cell has cell reaction:  $Zn + HgO \rightarrow ZnO + Hg$ . Which is the half-reaction occurring at the *anode*?

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- (A)  $\text{HgO} + 2\text{e}^- \rightarrow \text{Hg} + \text{O}^{2-}$ , (B)  $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$ , (C)  $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ , (D)  $\text{ZnO} + 2\text{e}^- \rightarrow \text{Zn}$
23. The overall reaction  $2\text{Co}^{3+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow 2\text{Co}^{2+}(\text{aq}) + \text{Cl}_2(\text{g})$  has the standard cell voltage  $\varepsilon^\circ_{\text{cell}} = 0.46 \text{ V}$ . Given that  $\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$ ,  $\varepsilon^\circ = 1.36 \text{ V}$ , calculate the standard reduction potential for the following the half reaction at  $25^\circ\text{C}$ :  $\text{Co}^{3+} + \text{e}^- \rightarrow \text{Co}^{2+}$   
(A) 1.82 V, (B) -0.90 V, (C) 0.90 V, (D) -1.82 V, (E) -1.36 V
24. How many coulombs of charge are required to cause reduction of 0.20 mole of  $\text{Cr}^{3+}$  to Cr?  
(A) 0.60 C, (B) 3.0 C, (C)  $2.9 \times 10^4 \text{ C}$ , (D)  $5.8 \times 10^4 \text{ C}$ , (E)  $9.65 \times 10^4 \text{ C}$
25. Consider the reaction of an acid in water:  
 $\text{HA}(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{A}^-(\text{aq})$   
If  $\text{A}^-$  is a better base than  $\text{H}_2\text{O}$ , which way will equilibrium lie?  
(A) To the left; (B) To the right; (C) There is no way to tell.
26. Consider the reaction of an acid in water:  
 $\text{HA}(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{A}^-(\text{aq})$   
If  $\text{A}^-$  is a better base than  $\text{H}_2\text{O}$ , is HA a weak acid or a strong acid?  
(A) HA is a strong acid; (B) HA is a weak acid; (C) There is no way to tell.
27. The equilibrium constant for  $\text{A} + 2\text{B} \rightleftharpoons 3\text{C}$  is  $2.1 \times 10^{-6}$ . Determine the equilibrium constant for  $2\text{A} + 4\text{B} \rightleftharpoons 6\text{C}$ .  
(A)  $4.2 \times 10^{-6}$ ; (B)  $4.4 \times 10^{-12}$ ; (C)  $2.3 \times 10^{11}$ ; (D)  $1.8 \times 10^{-11}$
28. For a certain reaction at  $25.0^\circ\text{C}$ , the value of  $K$  is  $1.2 \times 10^{-3}$ . At  $50.0^\circ\text{C}$ , the value of  $K$  is  $3.4 \times 10^{-1}$ . This means that the reaction is  
(A) exothermic; (B) endothermic; (C) more information is needed to answer the question.
29. For a first-order reaction  $a\text{A} \rightarrow \text{Products}$ , the first half-life is 20 minutes. What is the second half-life?  
(A) 10 minutes; (B) 20 minutes; (C) 40 minutes
30. Which of the following chemical or physical changes is an endothermic process?  
(A) The combustion of gasoline; (B) The evaporation of water; (C) The freezing of water; (D) The mixing of sulfuric acid and water
31. A solution is made by mixing ethyl alcohol ( $\text{C}_2\text{H}_5\text{OH}$ ) and water. What type of deviation from Raoult's law is expected for this solution?  
(A) Positive deviation; (B) Negative deviation; (C) No deviation
32. Which of the following compounds has the lowest boiling point?  
(A)  $\text{C}_2\text{H}_6$ , (B)  $\text{C}_3\text{H}_8$ , (C)  $\text{CH}_4$ , (D)  $\text{C}_5\text{H}_{12}$ , (E)  $\text{C}_4\text{H}_{10}$
33. Consider the following boiling point data and decide which liquid has the highest vapor pressure at room temperature:  
(A) Water,  $\text{H}_2\text{O}$ ,  $100^\circ\text{C}$ ; (B) Methanol,  $\text{CH}_3\text{OH}$ ,  $64.96^\circ\text{C}$ ; (C) Ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$ ,  $78.5^\circ\text{C}$ ;

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(D) Diethyl ether,  $\text{CH}_3\text{CH}_2\text{--O--CH}_2\text{CH}_3$ ,  $34.5^\circ\text{C}$ ; (E) Ethylene glycol,  $\text{HO--CH}_2\text{--CH}_2\text{--OH}$ ,  $198^\circ\text{C}$

34. Which of the following ionic compounds has the largest lattice energy (i.e., the lattice energy most favorable to a stable lattice)?  
(A) CsI, (B) NaCl, (C) LiF, (D) CsF, (E) MgO
35. Which of the following does not contain at least one double bond in the Lewis structure?  
(A)  $\text{H}_2\text{CO}$ , (B)  $\text{C}_2\text{H}_4$ , (C)  $\text{CO}_2$ , (D)  $\text{C}_3\text{H}_8$
36. Which of the following molecules has a dipole moment?  
(A)  $\text{BCl}_3$ , (B)  $\text{SiCl}_4$ , (C)  $\text{PCl}_3$ , (D)  $\text{Cl}_2$
37. Element X has a ground-state valence electron configuration of  $ns^2np^5$ . What is the most likely formula for the compound composed of element X and nitrogen?  
(A)  $\text{NX}$ , (B)  $\text{NX}_7$ , (C)  $\text{NX}_2$ , (D)  $\text{NX}_3$ , (E)  $\text{NX}_5$
38. Of the following elements, which has occupied  $d$  orbitals in its ground-state neutral atoms?  
(A) Ba, (B) Ca, (C) Si, (D) P, (E) Cl
39. Which of the following is the most polar bond without being considered ionic?  
(A) C—O, (B) Mg—O, (C) N—O, (D) O—O, (E) O—F
40. Given the equation  $\text{S}(s) + \text{O}_2(g) \rightarrow \text{SO}_2(g)$ ,  $\Delta H = -296 \text{ kJ}$ , which of the following statement(s) is (are) true?  
I. The reaction is exothermic.  
II. When 0.500 mol sulfur is reacted, 148 kJ of energy is released.  
III. When 32.0 g of sulfur is burned,  $2.96 \times 10^5 \text{ J}$  of energy is released.  
(A) All are true. (B) None is true. (C) I and II are true. (D) I and III are true. (E) Only II is true.

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1. Two girders are made of the same material. Girder A is twice as long as girder B and has a cross-sectional area that is twice as great. The ratio of the mass density of girder A to the mass density of girder B is?
2. A car starts from Hither, goes 50 km in a straight line to Yon, immediately turns around, and returns to Hither. The time for this round trip is 2 hours. The magnitude of the average velocity of the car for this round trip is? And the magnitude of the average speed of the car for this round trip is?
3. A ball rolls up a slope. At the end of three seconds its velocity is 20 cm/s; at the end of eight seconds its velocity is 0. What is the average acceleration from the third to the eighth second?
4. Each of four particles moves along an x axis. Their coordinates (in meters) as functions of time (in seconds) are given by: particle 1:  $x(t) = 3.5 - 2.7t^3$  particle 2:  $x(t) = 3.5 + 2.7t^3$  particle 3:  $x(t) = 3.5 + 2.7t^2$  particle 4:  $x(t) = 3.5 - 3.4t - 2.7t^2$ . Please calculate the acceleration for each particle and show which of these particles have constant acceleration?
5. Over a short interval, starting at time  $t = 0$ , the coordinate of an automobile in meters is given by  $x(t) = 27t - 4.0t^3$ , where  $t$  is in seconds. The magnitudes of the initial (at  $t = 0$ ) velocity and acceleration of the auto respectively are?
6. (a) A stone is tied to a 0.50-m string and whirled at a constant speed of 4.0 m/s in a vertical circle. Its acceleration at the bottom of the circle is? (b) A car rounds a 20-m radius curve at 10 m/s. The magnitude of its acceleration is?
7. (a) A 25-N crate slides down a frictionless incline that is  $25^\circ$  above the horizontal. The magnitude of the normal force of the incline on the crate is? (b) A 25-N crate is held at rest on a frictionless incline by a force that is parallel to the incline. If the incline is  $25^\circ$  above the horizontal the magnitude of the applied force is?
8. A sled is on an icy (frictionless) slope that is  $30^\circ$  above the horizontal. When a 40-N force, parallel to the incline and directed up the incline, is applied to the sled, the acceleration of the sled is  $2.0 \text{ m/s}^2$ , down the incline. The mass of the sled is?

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9. (a) A horizontal force of 12N pushes a 0.50-kg book against a vertical wall. The book is initially at rest. If  $\mu_s = 0.6$  and  $\mu_k = 0.80$ , the acceleration of the book in  $\text{m/s}^2$  is? (b) A horizontal force of 5:0N pushes a 0:50-kg block against a vertical wall. The block is initially at rest. If  $\mu_s = 0.6$  and  $\mu_k = 0.80$ , the acceleration of the block in  $\text{m/s}^2$  is?

10. (a) Camping equipment weighing 6000N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0.05. The work done by the campers in pulling the equipment 1000m at constant velocity is? (b) Camping equipment weighing 6000N is pulled across a frozen lake by means of a horizontal rope. The coefficient of kinetic friction is 0:05. How much work is done by the campers in pulling the equipment 1000m if its speed is increasing at the constant rate of  $0.20\text{m/s}^2$  ?