國立臺灣海洋大學 101 學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目：綜合化學

系所名稱：生物科技研究所碩士班乙組　　＊可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

PART I：單選題，每題 3 分。(共 60 分)

1. How many significant figures does the product 8.520 × 7.9 contain?
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

2. An oxide ion, O^{2-}, has:
(A) 8 protons and 10 electrons (B) 10 protons and 8 electrons (C) 8 protons and 9 electrons (D) 8 protons and 7 electrons (E) 10 protons and 7 electrons

3. Which of these elements is chemically similar to calcium?
(A) sulfur (B) magnesium (C) iron (D) nickel (E) potassium

4. The oxidation number for N in nitric acid, HNO_3, is
(A) -1 (B) 2 (C) -3 (D) 4 (E) 5

5. Identify the *major* ionic species present in an aqueous solution of Na_2CO_3.
(A) Na_2^+, CO_3^{2-} (B) Na_2^+, C^{2-}, O_3 (C) Na^+, C^{4+}, O_3^{2-} (D) Na^+, C^+, O^{2-} (E) Na^+, CO_3^{2-}

6. Based on the solubility rules, which of these processes will occur when a solution containing about 0.1 g of $Pb(NO_3)_2(aq)$ is mixed with a solution containing 0.1 g of KI(aq)/100 mL?
(A) KNO_3 will precipitate; Pb^{2+} and I^- are spectator ions. (B) No precipitate will form.
(C) $Pb(NO_3)_2$ will precipitate; K^+ and I^- are spectator ions.
(D) PbI_2 will precipitate; K^+ and NO_3^- are spectator ions.
(E) Pb^{2+} and I^- are spectator ions, and PbI_2 will precipitate.

7. A 100. mL sample of 0.200 M aqueous hydrochloric acid is added to 100. mL of 0.200 M aqueous ammonia in a calorimeter whose heat capacity (excluding any water) is 480. J/K. The following reaction occurs when the two solutions are mixed.
$HCl(aq) + NH_3(aq) \rightarrow NH_4Cl(aq)$
The temperature increase is 2.34°C. Calculate ΔH per mole of HCl and NH_3 reacted.
(A) 154 kJ/mol (B) 1.96 kJ/mol (C) 485 kJ/mol (D) -1.96 kJ/mol (E) -154 kJ/mol

8. For the following reaction:
$2\ H_2\ (g) + O_2\ (g) \rightarrow H_2O\ (l)$ $\Delta H° = -572$ kJ
What is the work associated with this reaction at 25°C?
(A) 7.4 kJ (B) 3.7 kJ (C) -3.7 kJ (D) 5.9 kJ (E) -4.5 kJ

9. Which of the following orbital designations is impossible?
(A) n=2, $l = 0$, $m_l = 0$ (B) n=3, $l = 0$, $m_l = 0$ (C) n=3, $l = 1$, $m_l = 1$ (D) n=3, $l = 2$, $m_l = -1$ (E) n=3, $l = 3$, $m_l = -3$

10. Which of the following atoms (Ar, Ca, Zn, Br) would you expect to be diamagnetic?
(A) Ar, Ca and Zn only (B) Ar and Br only (C) Zn and Ca only (D) Ar only (E) All are diamagnetic

11. Calculate the energy, in joules, required to excite a hydrogen atom by causing an electronic transition from the n = 1 to the n = 4 principal energy level. Recall that the energy levels of the H atom are given by $E_n = -2.18 \times 10^{-18}\ J(1/n^2)$
(A) 2.07×10^{-29} J (B) 2.19×10^{5} J (C) 2.04×10^{-18} J (D) 3.27×10^{-17} J
(E) 2.25×10^{-18} J

12. Which of the following statements is *incorrect* according to MO theory?
(A) O_2 is paramagnetic (B) O_2^{2-} is diamagnetic (C) O_2^{2-} has a greater bond strength than O_2 (D) O_2^{2+} has a greater bond strength than O_2 (E) O_2^{4+} has the same bond strength as O_2

13. Which of these molecules is *unsaturated*?
(A) C_3H_8 (B) CH_3OH (C) C_5H_{10} (D) CH_4 (E) C_4H_{10}

14. The solubility of CO_2 gas in water
(A) increases with increasing gas pressure (B) increases with decreasing gas pressure (C) decreases with increasing gas pressure (D) is not dependent on pressure (E) is not dependent on temperature

15. Which process would you expect to require the most energy?
(A) The conversion of 1 mole of solid ethanol to 1 mole of liquid ethanol
(B) The conversion of 1 mole of solid chloroethane to 1 mole of liquid chloroethane
(C) The conversion of 1 mole of solid ethane to 1 mole of liquid ethane
(D) The conversion of 1 mole of liquid ethanol to 1 mole of gaseous ethanol
(E) The conversion of 1 mole of liquid chloroethane to 1 mole of gaseous chloroethane

16. A certain first-order reaction C→ D is 25% complete in 12 min at 25°C. What is the half-life of the reaction?
(A) 12 min (B) 24 min (C) 30 min (D) 36 min (E) 6min

17. The acid dissociation constant for hexanoic acid is 1.41×10^{-5}. A buffer solution is prepared by mixing hexanoic acid and sodium hexanoate and is found to have a pH of 4.9. What is the ratio of the salt to acid concentration in this buffer solution?
(A) 0 (B) 0.3 (C) 0.8 (D) 1.0 (E) 2.0

18. HI has a normal boiling point of -35.4°C, and its ΔH_{vap} is 21.16 kJ/mol. Calculate the molar entropy of vaporization (ΔS_{vap}).
(A) 598 J/K·mol (B) 68.6 J/K·mol (C) 75.2 J/K·mol (D) 0.068 J/K·mol (E) 89.0 J/K·mol

19. Which of the following complex ions do you expect would absorb photons with the greatest energy?
(A)$[Cr(H_2O)_6]^{2+}$ (B) $[CrCl_6]^{4-}$ (C) $[Cr(CN)_6]^{4-}$ (D) $[Cr(CN)_6]^{2-}$ (E) $[Cr(H_2O)_4]^{2+}$

20. The segment -$CH_2CH_2CH_2CH_2CH_2CH_2$- represents the polymer named
(A) polybutylene. (B) polyhexene (C) polypropylene (D) polystyrene.

(E) polyethylene.

PART II：簡答題及計算題，每題 10 分。(共 40 分)

1. Given the information that

$$Fe^{3+} + Y^{4-} \leftrightarrow FeY^{-} \qquad K_f = 1.0 \times 10^{25}$$

$$Cu^{2+} + Y^{4-} \leftrightarrow CuY^{2-} \qquad K_f = 6.3 \times 10^{18}$$

and the further information that, among the several reactants and products, only CuY^{2-} absorbs at 750 nm, describe how Cu(II) could be used as indicator for the photometric titration of Fe(III) with H_2Y^{2-}.
Reaction: $Fe^{3+} + H_2Y^{2-} \rightarrow FeY^{-} + 2H^{+}$

2. Please detail describe the following equation for real gas

$$\left[P_{obs} + a\left(\frac{n}{V}\right)^2\right]\underbrace{(V - nb)} = nRT$$

3. What is the equilibrium constant for the following reaction at 25 ^{0}C?
$O_3(g) + NO(g) \rightarrow NO_2(g) + O_2(g)$ ($\Delta H° = -199$ kJ/mol, $\Delta S° = -4.1$ J/K·mol)

4. Given the following standard reduction potentials,
$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ $\quad E° = 0.80$ V
$AgCN(s) + e^{-} \rightarrow Ag(s) + CN^{-}(aq)$ $\quad E° = -0.01$ V
calculate the solubility product of AgCN at 25°C.