國立中正大學
108學年度碩士班招生考試
試 題

[第1節]

系所組別	化學暨生物化學系
科目名稱	一般化學

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。

3. 入場後於考試開始40分鐘內不得離場。

4. 全部答題均須在試卷（答案卷）作答區內完成。

5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。

6. 試題須隨試卷繳還。

單一選擇題，共 30 題，每題 3 分，共 90 分，答錯不倒扣。請在答案卷上作答。

1. Which of the following statements are *true* of uranium-238?

      I. Its chemical properties will be exactly like those of uranium-235.

      II. Its mass will be slightly different from that of an atom of uranium-235.

      III. It will contain a different number of protons that an atom of uranium-235.

      IV. It is more plentiful in nature than uranium-235.

(a) III, IV, (b) I, II, III, (c) I, II, IV, (d) II, III, IV, (e) all of these.

2. Which of the following pairs can be used to illustrate the law of multiple proportions?

(a) SO and SO_2, (b) CO and $CaCo_3$, (c) H_2O and $C_{12}H_{22}O_{11}$, (d) H_2SO_4 and H_2S, (e) KCl and $KClO_2$.

3. The atomic mass of rhenium is 186.2. Given that 37.1% of natural rhenium is rhenium-185, what is the other stable isotope?

(a) $^{183}_{75}Re$, (b) $^{187}_{75}Re$, (c) $^{189}_{75}Re$, (d) $^{181}_{75}Re$, (e) $^{190}_{75}Re$.
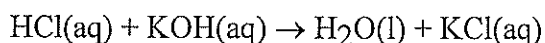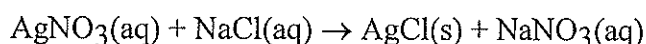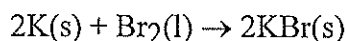
4. Nitric acid contains what percent hydrogen by mass?

(a) 20.0, (b) 10.0, (c) 4.50, (d) 1.60, (e) 3.45%.

5. What volume of 18.0 M sulfuric acid must be used to prepare 15.5 L of 0.195 M H_2SO_4?

(a) 168, (b) 336, (c) 92.3, (d) 226 mL, (e) none of these.

6. The following reactions

    $2K(s) + Br_2(l) \rightarrow 2KBr(s)$

    $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

    $HCl(aq) + KOH(aq) \rightarrow H_2O(l) + KCl(aq)$

are examples of

(a) precipitation reactions. (b) redox, precipitation, and acid-base, respectively. (c) precipitation (two) and acid-base reactions, respectively. (d) redox reactions. (e) none of these.

7. A gas sample is held at constant pressure. The gas occupies 3.62 L of volume when the temperature is 21.6°C. Determine the temperature at which the volume of the gas is 3.45 L.

(a) 309, (b) 281, (c) 20.6, (d) 294, (e) 326 K.

8. Given reaction $N_2 + 3H_2 \rightarrow 2NH_3$, you mix 1 mol each of nitrogen and hydrogen gases under the same conditions in a container fixed with a piston. Calculate the ratio of volumes of the container ($V_{final}/V_{initial}$).

(a) 0.67, (b) 1.00, (c) 1.33, (d) 1.50, (e) none of these.

9. Consider the reaction $H_2 + I_2 \rightleftharpoons 2HI$ whose $K = 54.8$ at 425°C. If an equimolar mixture of reactants gives the concentration of the product to be 0.50 M at equilibrium, determine the concentration of the hydrogen.

(a) 1.6×10^{-4}, (b) 1.2×10^{-3}, (c) 4.6×10^{-3}, (d) 6.8×10^{-2}, (e) 9.6×10^{-2}.

10. Consider the following system at equilibrium:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 92.94 \text{ kJ}$$

Which of the following changes will shift the equilibrium to the right?

I. increasing the temperature;　II. decreasing the temperature;　III. increasing the volume;
IV. decreasing the volume;　V. removing some NH_3; VI. adding some NH_3; VII. removing some N_2;
VIII. adding some N_2

(a) I, IV, VI, VII, (b) II, III, V, VIII, (c) I, VI, VIII, (d) I, III, V, VII, (e) II, IV, V, VIII.

11. 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. The relative order of base strengths is:

(a) $F^- > H_2O > CN^-$, (b) $H_2O > F^- > CN^-$, (c) $CN^- > F^- > H_2O$, (d) $F^- > CN^- > H_2O$, (e) none of these.

12. Approximately how much water should be added to 10.0 mL of 12.0 M HCl so that it has the same pH as 0.90 M acetic acid ($K_a = 1.8 \times 10^{-5}$)?

(a) 30 mL, (b) 300 mL, (c) 3 L, (d) 30 L, (e) 300 L.

13. Calculate the pH of a solution that is 0.5 M in HF ($K_a = 7.2 \times 10^{-4}$) and 0.6 M in NaF.

(a) 1.72, (b) 3.32, (c) 4.44, (d) 5.53, (e) 8.46.

14. For a solution equimolar in HCN and NaCN, which statement is false?

(a) This is an example of the common ion effect.
(b) The $[H^+]$ is larger than it would be if only the HCN was in solution.
(c) The $[H^+]$ is equal to the K_a.
(d) Addition of more NaCN will shift the acid dissociation equilibrium of HCN to the left.
(e) Addition of NaOH will increase $[CN^-]$ and decrease [HCN].

15. Which of the following statements correctly describes the signs of q and w for the following exothermic process at $P = 1$ atm and $T = 370$ K?

$$H_2O(g) \quad \rightarrow \quad H_2O(l)$$
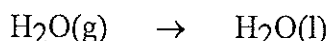
(a) q and w are negative. (b) q is positive, w is negative. (c) q is negative, w is positive. (d) q and w are both positive. (e) q and w are both zero.

16. Given the equation $S(s) + O_2(g) \rightarrow SO_2(g)$, $\Delta H = -296$ kJ, which of the following statement(s) is (are) true?

I. The reaction is exothermic.
II. When 0.500 mole sulfur is reacted, 148 kJ of energy is released.
III. When 32.0 g of sulfur are burned, 2.96×10^5 J of energy is released.

(a) Only I is true. (b) Only II is true. (c) I and II are true. (d) I and III are true. (e) I, II, and III are true.

17-18. The enthalpy of vaporization of ethanol is 38.7 kJ/mol at its boiling point (78°C).
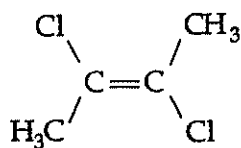
17. Calculate the value of ΔS_{surr} when 1.00 mole of ethanol is vaporized at 78.0°C and 1.00 atm.

(a) 0, (b) 496, (c) 110, (d) –110, (e) –496 J/K mol.

18. Calculate the value of ΔS when 1.00 mole of ethanol is vaporized at 78.0°C and 1.00 atm.

(a) 0, (b) 496, (c) 110, (d) –110, (e) –496 J/K mol.

19. Name the following:

(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.

20. How many structural and geometrical isomers are there of chloropropene?

(a) 2, (b) 3, (c) 4, (d) 5, (e) none of these.

21. Which of the following is *not* determined by the principal quantum number, n, of the electron in a hydrogen atom?

(a) the energy of the electron.
(b) the minimum wavelength of the light needed to remove the electron from the atom.
(c) the size of the corresponding atomic orbital(s).
(d) the shape of the corresponding atomic orbital(s).
(e) All of these are determined by n.

22. On a planet where the temperature is so high, the ground state of an electron in the hydrogen atom is $n = 4$. What is the ratio of IE on this planet compared to earth?

(a) 1 : 4, (b) 4 : 1, (c) 1 : 16, (d) 16 : 1, (e) 1 : 1.

23. How many of the following molecules possess dipole moments?
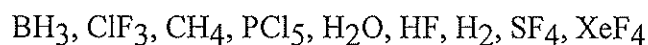
BH_3, ClF_3, CH_4, PCl_5, H_2O, HF, H_2, SF_4, XeF_4
(a) 1, (b) 2, (c) 3, (d) 4, (e) 5.

24. Which of the following molecules (or ions) has a dipole moment?

(a) CO_2, (b) CO_3^{2-}, (c) NH_4^+, (d) PF_3, (e) none of these.

25. The hybridization of Cl in ClF_3 is

(a) sp, (b) sp^2, (c) sp^3, (d) $dsp3$, (e) d^2sp^3.

26. Which of the following diatomic molecules has a bond order of 2?

(a) B_2, (b) C_2 (c) P_2, (d) F_2, (e) Na_2.

27-28. The reaction A → B + C is known to be zero order in A with a rate constant of 5.0×10^{-2} mol/L· s at 25°C. An experiment was run at 25°C where $[A]_0 = 1.0 \times 10^{-3}$ M.

27. After 5.0 minutes, the rate is
(a) 5.0×10^{-2}, (b) 2.5×10^{-2}, (c) 1.2×10^{-2}, (d) 1.0×10^{-3} mol/L· s, (e) none of these.

28. The half-life for the reaction is
(a) 1.0×10^{-2}, (b) 1.0×10^{2}, (c) 5.0×10^{-2}, (d) 5.0×10^{-4} s, (e) none of these.

29. A metal crystallizes with a face-centered cubic lattice. The edge of the unit cell is 408 pm. The diameter of the metal atom is:

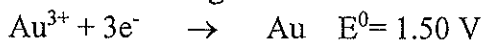(a) 144, (b) 204, (c) 288, (d) 408 pm, (e) none of these.

30. Which one of the following statements about solid Cu (face-centered cubic unit cell) is incorrect?

(a) It will conduct electricity.

(b) There are two atoms per unit cell.

(c) The number of atoms surrounding each Cu atom is 12.

(d) The solid has a cubic closest-packed structure.

(e) The length of a face diagonal is four times the Cu radius.

非選擇題，共 10 分。請在答案卷上作答。

1. How many unpaired electrons are in the following complex ions? (a) $[Cr(CN)_6]^{4-}$, (b) $[Co(NH_3)_6]^{3+}$, (c) $[CoF_6]^{3-}$, and (d) $[Ru(NH_3)_6]^{2+}$. (4分)

2. Consider the galvanic cell based on the following half-reactions:
$$Au^{3+} + 3e^- \rightarrow Au \quad E^0 = 1.50 \text{ V}$$
$$Tl^+ + e^- \rightarrow Tl \quad E^0 = -0.34 \text{ V}$$
(a) Determine the overall cell reaction and calculate E^0_{cell}.
(b) Calculate $\Delta G°$ and K for the cell reaction at 25°C.
(c) Calculate E_{cell} at 25°C when $[Au^{3+}] = 1.0 \times 10^{-2}$ M and $[Tl^+] = 1.0 \times 10^{-4}$ M. (6分)