

中原大學 94 學年度碩專班入學考試

3 月 5 日 13 : 00-14:30 化學系

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

科目：綜合化學

(共 6 頁第 1 頁)

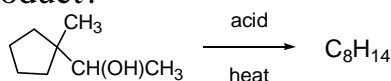
☑可使用計算機，惟僅限不具可程式及多重記憶者

各題答案一律作答於答案卷內，不可直接作答於本試題

Section I. 有機化學 (25%)

(A) 選擇題(單選, 20%)

1. The reaction below yields a product (C_8H_{14}) which contains no cyclopentane ring. What is the likely product?



- (1) cyclooctene (2) 1, 2-dimethylcyclohexene (3) 3, 3-dimethylcyclohexene (4) 1-octyne (5) 1, 2, 3, 4-tetramethylcyclobutene.

2. Please determine the order of stability of the following carbon cations (most stable first):

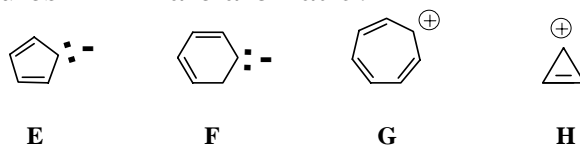


- (1) D, B, C, A (2) B, A, C, D (3) B, C, A, D (4) D, B, A, C (5) B = D, C, A.

3. The eclipsed and staggered forms of ethane are said to differ in :

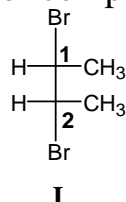
- (1) molecular structure (2) configuration (3) conformation (4) constitution (5) enantiomer

4. Which of the molecules **E** – **H** are aromatic?



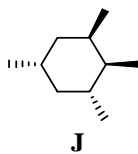
- (1) E, G and H (2) F, G and H (3) G and H (4) E and H (5) all of the molecules.

5. Which of the following statements of compound **I** is correct?



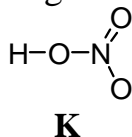
- (1) The configurations of C-1 and C-2 are R and R, respectively. (2) The configurations of C-1 and C-2 are S and R, respectively. (3) The configurations of C-1 and C-2 are S and S, respectively. (4) The configurations of C-1 and C-2 are R and S, respectively. (5) Compound **I** is an optically active compound.

6. In the most stable conformation of **J**, how many methyl groups are in equatorial positions?



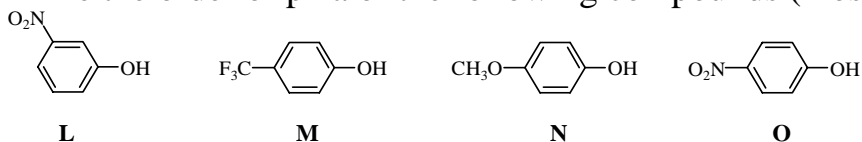
(1) 0 (2) 1 (3) 2 (4) 3 (5) 4 .

7. What is the formal charge on the nitrogen atom of compound **K**?



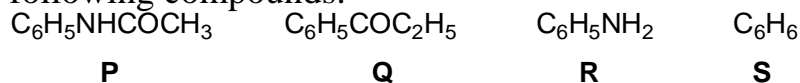
(1) -2 (2) -1 (3) 0 (4) +1 (5) +2 .

8. Please determine the order of pKa of the following compounds (most largest first):



(1) L, M, N, O (2) O, M, L, N (3) O, L, M, N (4) L, O, M, N (5) N, M, L, O.

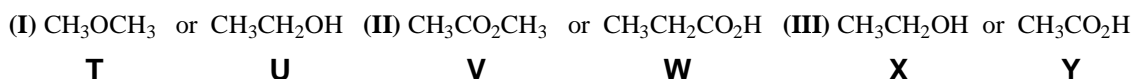
9. Consider the following compounds:



If one wishes to list these in order of increasing reactivity to NO_2^+ , the correct order is:

(1) P, R, Q, S (2) R, Q, S, P (3) S, Q, P, R (4) Q, S, R, P (5) Q, S, P, R.

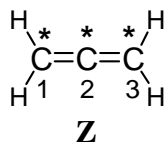
10. In each case pick the compound with the higher boiling point.



(1) T, W, Y (2) U, V, Y (3) U, W, Y (4) U, W, X (5) T, V, X.

- (B) 問答題 (5%)

State the number of σ and π bonds in the compound **Z** and indicate the hybridization schemes involved with the starred atoms. Also show the geometry of the compound **Z**.



Section II. Physical Chemistry (25%), 單選題, 一題 5 分

- 1. Which of the following atomic orbitals is spherical symmetric?**
(A) s (B) p (C) d (D) f
- 2. For a spontaneous process in an isolated system**
(A) $\Delta H > 0$ (B) $\Delta U > 0$ (C) $\Delta S > 0$ (D) $\Delta G > 0$
- 3. At the phase boundary, which of the following quantity is equal between the two phases?**
(A) volume (B) enthalpy (C) entropy (D) chemical potential
- 4. If a binary mixture A+B can form a high-boiling azeotrope, which of the following statement is incorrect?**
(A) A maximum exists in the phase diagram (B) A-B interactions stabilize the liquid (C) A-B interactions reduce the vapor pressure of the mixture below the ideal value (D) The excess Gibbs energy is positive
- 5. At constant temperature, the collision frequency of gas molecules is proportional to**
(A) pressure (B) volume (C) entropy (D) enthalpy

Section III. 無機學門考 (25%)

填寫下列表格，須標明題序及表格序，作答於答案卷，不可直接作答於本試題

1. Predict the structures of the following ions.

	NH_2^-	NH_4^+	I_3^-	PCl_6^-
Structure	(A)	(B)	(C)	(D)

2. Verify the point groups of the following molecules.

Molecule	$\text{B}(\text{OH})_3$ planar	H_2O	BrF_5 Square pyramid	BF_3
Point group	(A)	(B)	(C)	(D)
Molecule	$\text{Os}(\text{C}_5\text{H}_5)_2$ Eclipsed	C_6H_6 benzene	$\text{Fe}(\text{C}_5\text{H}_5)_2$ Staggered	C_2H_2
Point group	(E)	(F)	(G)	(H)

3. Sketch the overlap region of the following combination of orbitals, all with collinear Z axes. Classify the overlap.

Orbitals	P_x and d_{xz}	P_z and d_{z^2}	S and $\text{d}_{x^2-y^2}$
Sketch the overlap regions	(A)	(C)	(E)
Overlap status	(B)	(D)	(F)

(*U.C.: unit cell)

	Simple Cubic	Body-Centered Cubic	Face-Centered Cubic
Coordination Number	(A)	(D)	(F)
Number of Atoms in U.C.*	(B)	(E)	(G)
Atomic Packing Factor	(C)	0.68	0.74

Section IV. Analytical Chemistry (25%)**(10 questions, 2.5 points for each correct answer, 0 point for each wrong answer).**

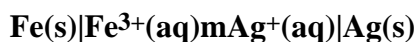
1. Given:

acetic acid, $pK_a = 4.75$ HSO_4^- , $pK_a = 1.92$ HF, $pK_a = 3.45$

The order of these acids from strongest to weakest is

- A) $\text{HSO}_4^- > \text{acetic acid} > \text{HF}$ D) $\text{HSO}_4^- > \text{HF} > \text{acetic acid}$
B) $\text{HF} > \text{acetic acid} > \text{HSO}_4^-$ E) $\text{HF} > \text{HSO}_4^- > \text{acetic acid}$
C) $\text{acetic acid} > \text{HF} > \text{HSO}_4^-$
2. The pK_a for HF is 3.45. This expression refers to which of the following reactions?
A) $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons 2\text{H}_2\text{O}(\text{l})$
B) $\text{F}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{HF}(\text{aq}) + \text{OH}^-(\text{aq})$
C) $\text{F}^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq}) \rightleftharpoons \text{HF}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
D) $\text{HF}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{F}^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$
E) $\text{HF}(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{F}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
3. For the titration of 25.0 mL of 0.100 M $\text{HClO}(\text{aq})$ ($pK_a = 7.5$) with 0.100 M $\text{NaOH}(\text{aq})$, the main species in solution after addition of 25.0 mL of base are
A) $\text{HClO}(\text{aq})$, $\text{ClO}^-(\text{aq})$, and $\text{Na}^+(\text{aq})$. D) $\text{HClO}(\text{aq})$, $\text{H}^+(\text{aq})$, and $\text{ClO}^-(\text{aq})$.
B) $\text{ClO}^-(\text{aq})$ and $\text{Na}^+(\text{aq})$. E) $\text{ClO}^-(\text{aq})$ and $\text{H}^+(\text{aq})$.
C) $\text{HClO}(\text{aq})$, $\text{OH}^-(\text{aq})$, and $\text{Na}^+(\text{aq})$.
4. The relationship between the molar solubility in water, s , and K_{sp} for the ionic solid $\text{Fe}(\text{OH})_2$ is
A) $K_{sp} = s^2$ B) $K_{sp} = s$ C) $K_{sp} = s^3$ D) $K_{sp} = 4s^3$ E) $K_{sp} = 2s^2$
5. The pH of a 0.050 M aqueous solution of calcium hydroxide is
A) 13.00 B) 12.70 C) 12.40 D) 12.00 E) 1.00

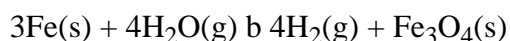
6. The standard potential of the Ag^+/Ag electrode is +0.80 V and the standard potential of the cell



is +0.84 V. What is the standard potential of the Fe^{3+}/Fe electrode?

- A) +1.64 V B) -1.64 V C) -0.12 V D) +0.04 V E) -0.04 V
7. Consider the following reaction:
- $$\text{H}_2\text{O(g)} + \text{C(s)} \rightleftharpoons \text{H}_2(\text{g}) + \text{CO(g)}$$
- If the value of K_p for this reaction is 3.72 at 1000 K, and the equilibrium partial pressures of $\text{H}_2(\text{g})$ and CO(g) are 1.50 atm, calculate the equilibrium partial pressure of $\text{H}_2\text{O(g)}$.
- A) 0.403 atm B) 1.65 atm C) 2.48 atm D) 1.50 atm E) 0.605 atm
8. If a small amount of HCl(aq) is added to 0.10 M $\text{NH}_3(\text{aq})$,
- A) the equilibrium concentration of $\text{NH}_4^+(\text{aq})$ is increased.
B) K_a becomes larger.
C) no change occurs.
D) the equilibrium concentration of the ammonium ion is decreased.
E) the equilibrium concentration of ammonia increases.

9. Consider the reaction



If the total pressure is increased suddenly by reducing the volume,

- A) more $\text{H}_2(\text{g})$ is produced. D) more $\text{H}_2\text{O(g)}$ is produced.
B) no change occurs. E) the equilibrium constant increases.
C) more Fe(s) is produced.
10. Which one of the following 0.10 M aqueous solutions has the lowest pH?
- A) HF B) NaCH_3CO_2 C) KNO_2 D) $\text{Ca}(\text{ClO}_4)_2$ E) NaClO_4