

# 東吳大學 109 學年度碩士班研究生招生考試試題

第1頁，共3頁

系級	化學系碩士班	考試時間	100 分鐘
科目	綜合化學	本科總分	100 分

※一律作答於答案卷上(題上作答不予計分)；並務必標明題號，依序作答。

## Part A:

一、

1. Draw resonance structures for  $\text{SCN}^-$  (carbon is the central atom) (6 points)
2. Draw the possible isomers for the following compounds: (a)  $[\text{Co}(\text{en})_3]^{3+}$  (2 points) (b)  $[\text{Co}(\text{en})_2\text{Cl}_2]$  (3 points). (en = ethylenediamine)
3. Explain the following terms: (a) Pauli exclusion principle (b) Hund's rule (c) Nodal surface (d) Shielding effect. (8 points, 2 points for each)
4. Determine the number of unpaired electrons for each of the following complexes: (a)  $[\text{Co}(\text{CO})_4]^-$  ( $T_d$ ) (b)  $[\text{Cr}(\text{CN})_6]^{4-}$  ( $O_h$ , low-spin) (c)  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  ( $O_h$ , high-spin) (d)  $[\text{Co}(\text{NO}_2)_6]^{4-}$  ( $O_h$ , high-spin) (e)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  ( $O_h$ , low-spin) (f)  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ( $O_h$ ). (6 points, 1 point for each)

二、

1. The temperature of 4.05 moles of an ideal gas increases from 15 to 55°C as the gas is compressed adiabatically. Calculate  $q$ ,  $w$ ,  $\Delta U$ , and  $\Delta H$  for this process assuming that  $C_{V,m} = 3/2 R$ . (8 points)
2. Pulse lasers are useful sources of nearly monochromatic radiation. Lasers that emit photons in a pulse of 3.5 ns duration with a total energy in the pulse of 0.158 J at 835 nm. (4 points)
  - (a) What is the average power (energy per unit time) in units of watts (a  $W = 1 \text{ J/s}$ ) associated with such a pulse?
  - (b) How many photons are emitted in such a pulse?
3. As known the function  $\psi(x) = A(y/b)[1 - (y/b)]$  is an acceptable wavefunction for the 1-D infinite depth box of length  $b$ . Calculate the normalization constant  $A$  and expectation value  $\langle y \rangle$  and  $\langle y^2 \rangle$  (6 points)
4. Determine the total collisional frequency for  $\text{CO}_2$  at 2 atm and 300 K. And at what temperature would the collisional frequency be 20% of the value determined in previously state? As known for  $\text{CO}_2$ ,  $\sigma = 5.2 \times 10^{-19} \text{ m}^2$  and  $M = 0.044 \text{ kg/mol}$ . (7 points)

背後尚有試題

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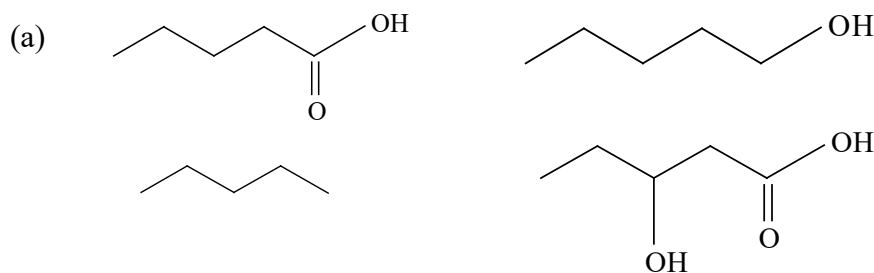
**PartB:**

1. Define the following terms: (20 分)

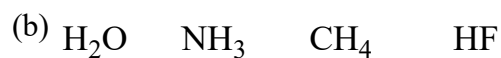
- (a) Resonance fluorescence.
- (b) Retention time.
- (c) Liquid junction potential.
- (d) Internal standard.

2. A 50 mL of 0.05M NaCN solution is titrated with 0.1M HCl. Calculate the pH after the addition of 10 mL of acid.  $K_a$  for HCN= $6.2 \times 10^{-10}$ . (5 分)

3. Rank the following groups of compounds in order of decreasing solubility in water. (4 分)

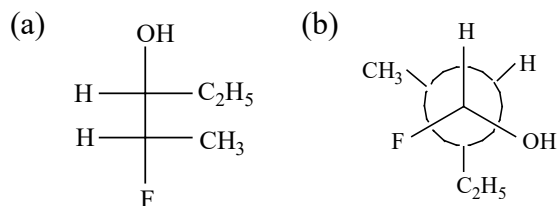


4. Rank the following compounds from strongest acid to weakest acid. (4 分)



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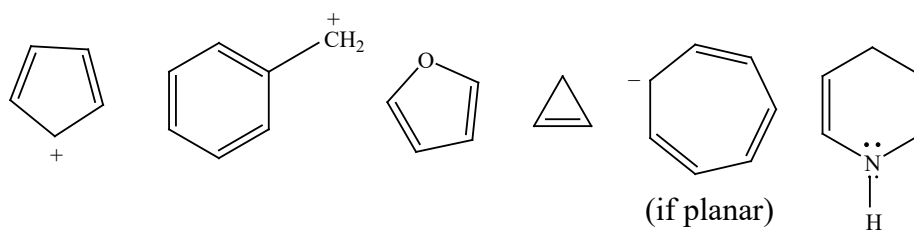
5. Label each chiral carbon as (R) or (S). (4 分)



6. For  $S_N1$  reaction:  $RX + Nu^- \longrightarrow RNu + X^-$   
which one makes the reaction faster? (4 分)

- (1) A:  $CH_3CH_2CH_2CH_2Br$                       B:  $(CH_3)_3CBr$   
 (2) A: 1M  $CH_3OH$                               B: 2M  $CH_3OH$   
 (3) A: 1M  $RX$                                       B: 2M  $RX$   
 (4) A:  $RI$     B:  $RBr$

7. Classify the following species as aromatic, nonaromatic, or antiaromatic: (6 分)



8. Derive the structure of a compound  $C_{11}H_{16}$  based on the following spectrum. (3 分)

