

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）**Inorganic Chemistry and Analytical Chemistry (total points: 100)****Part I: Inorganic Chemistry (total points: 50)**

- (1) List the acids  $\text{H}_2\text{O}$ ,  $\text{HCl}$ ,  $\text{HI}$ ,  $\text{CH}_4$  in order of increasing gas-phase acidity and briefly explain your answer. (5%)
- (2) Which of the following complexes obey the rule of 18 (EAN rule). Show the calculation for each complex. (5%)  
(a)  $\text{Fe}(\text{CO})_5$  (b)  $\text{Fe}(\text{CN})_6^{4-}$  (c)  $\text{Fe}(\text{CN})_6^{3-}$
- (3) List the following Lewis base in order of decreasing basic strength toward to  $\text{B}(\text{CH}_3)_3$  and indicate the major factors governing your answer. (10%)  
(a) pyridine (b) 4-dimethylpyridine (c) 2-methylpyridine
- (4) Sketch  $\pi$  bond orbitals that result from combination of the following orbitals on separate atoms: (10%)  
(a)  $p_x$  and  $p_x$  (b)  $p_x$  and  $d_{xz}$
- (5) Rationalize the trends in following set of IR-active CO stretching frequencies (in  $\text{cm}^{-1}$ ) (10%)
- |                               |      |
|-------------------------------|------|
| $\text{Ni}(\text{CO})_4$      | 2046 |
| $\text{Co}(\text{CO})_4^{-1}$ | 1883 |
| $\text{Fe}(\text{CO})_4^{-1}$ | 1788 |
- (6) A pink solid has the empirical formula  $\text{CoCl}_3 \cdot 5\text{NH}_3 \cdot \text{H}_2\text{O}$ . A solution of this salt is also pink and rapidly gives 3 mol  $\text{AgCl}$  on titration with  $\text{AgNO}_3$  solution. When the pink solid is heated, it loses 1 mol  $\text{H}_2\text{O}$  to give a purple solid with the same ratio of  $\text{NH}_3:\text{Cl}:\text{Co}$  (recall that  $\text{Co}(\text{III})$  complexes are inert). Deduce the structures of the two octahedral complexes and draw and name them. (10%)

(背面仍有題目,請繼續作答)

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Part II: Analytical Chemistry (Total points: 50)

- (1) Two blue solutions, each known to contain only one absorbing species, had the following absorbances in a 1.00-cm cell:

Solution	$A$ at 770 nm	$A$ at 820 nm
1	0.622	0.417
2	0.391	0.240

Do the solutions contain the same substance? Explain how you know. (5%)

- (2) Two solutes with distribution ratios of 1.47 and 1.86 are to be separated on a column whose volume ratio of stationary phase to mobile phase ( $V_S/V_M$ ) is 13.6.

- (a) How many theoretical plates are needed to ensure a resolution of 1.35? (5%)  
 (b) What length of column is required for part (a) if  $H$  (height of a theoretical plate) is 0.250 cm? (5%)

- (3) A new procedure for the rapid determination of sulfur in kerosenes was tested on a sample known from its method of preparation to contain 0.121% S. The results were % S = 0.122, 0.119, 0.117, 0.116.

- (a) Calculate the standard deviation of the results. (5%)  
 (b) Determine the 95% confidence interval ( $t$  value = 3.18) for the results. (5%)  
 (c) Do the data indicate that there is a determinate error in the method? (5%)

- (4) Consider solutions prepared by

- (i) dissolving 8.00 mmol of NaOAc in 200 mL of 0.100 M HOAc  
 (ii) adding 40.0 mL of 0.1200 M HCl to 160.0 mL of 0.0420 M NaOAc

- (a) Calculate the pH of each solution. (5%)  
 (b) Which solution has the greater buffer capacity? Why? (5%)

- (5) The cell SCE ||  $I^-$  ( $x$  M),  $PbI_2$  (s) | Pb

- (a) Develop an equation that relates the potential of the cell to pI. (5%)  
 (b) Calculate pI if the cell has a potential of  $-0.348$  V (5%)

$$K_{sp} = [Pb^{2+}][I^-]^2 = 7.9 \times 10^{-9}$$

$$E_{Pb^{2+}/Pb}^0 = -0.126 \text{ V}$$

$$E_{SCE} = 0.244 \text{ V}$$