

# 淡江大學 98 學年度碩士班招生考試試題

系別：化學學系(化學組)

科目：無機化學

本試題共 一 頁，八 大題

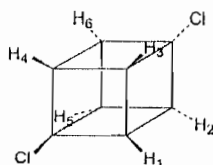
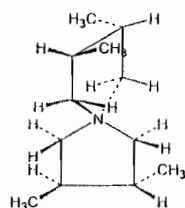
Notes : 1. 請按照題目順序答題。

2. 推論過程呈現得愈清楚，可獲得愈高的評分。

1. Find the lowest energy atomic term for the following species:  
 a)  $\text{Cl} [\text{Ne}]3s^23p^5$       b)  $\text{Na} [\text{Ne}]3s^1$       c)  $\text{Sc} [\text{Ar}]3d^14s^2$  (10)

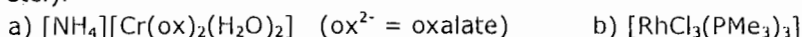
2. For the  $\text{SOF}_4$  molecule, write the Lewis dot structure that minimizes formal charge, give the formal charge and oxidation number on each atom, draw the molecular shape, give the likely hybrid on the central atom, and give the point group. (12)

3. Assign the point groups of the following molecules. Is the compound below left optically active? Which of the protons in the cubane molecule below right are equivalent? (10)



4. Consider the  $\text{CN}^-$  ion.  
 a) Prepare a molecular orbital energy diagram for the ion. What is the bond order and how many unpaired electrons are in this ion?  
 b) What is the most likely position for adding  $\text{H}^+$  to the  $\text{CN}^-$ ? Explain your choice based on the nature of the HOMO. (14)

5. Draw each of the following coordination complexes. State whether the complex ion has isomers and, for those which do, draw the isomers and indicate which isomer is which (cis/trans,  $\Delta/\Lambda$ , etc.). (10)



6. In which of the following complexes would  $\Delta_o$  be larger and why?  
 a)  $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$  and  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$       b)  $[\text{CrF}_6]^{3-}$  and  $[\text{Cr}(\text{NH}_3)_6]^{3+}$   
 c)  $[\text{Fe}(\text{CN})_6]^{3-}$  and  $[\text{Fe}(\text{CN})_6]^{4-}$       d)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$  and  $[\text{Ni}(\text{en})_3]^{2+}$   
 e)  $[\text{MnF}_6]^{2-}$  and  $[\text{ReF}_6]^{2-}$       f)  $[\text{Co}(\text{en})_3]^{3+}$  and  $[\text{Rh}(\text{en})_3]^{3+}$  (12)

7. When  $\text{CoCl}_2$  is dissolved in water, a pale colored pink solution is obtained. On adding conc.  $\text{HCl}$  the solution turns an intense blue color. Suggest structures for the pink and the blue complexes, and draw the appropriate orbital splitting diagrams. What is the reason for the change in color? Calculate the spin-only magnetic moments of the two complexes you propose. (12)

8. a) Determine the spin multiplicity for the following species:  
 i)  $[\text{MnF}_6]^{4-}$       ii)  $[\text{Fe}(\text{CN})_6]^{3-}$   
 b) Indicate which of the following complexes exhibits a distorted octahedral geometry.  
 i)  $[\text{Ti}(\text{H}_2\text{O})_6]^+$       ii)  $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$       iii)  $[\text{Fe}(\text{CN})_6]^{4-}$   
 c) For the following two molecules, determine the ground state and the number of spin-allowed d-d transitions:  
 i)  $[\text{Ti}(\text{CN})_4]^{2-}$       ii)  $[\text{Fe}(\text{H}_2\text{O})_6]^{+2}$   
 d)  $\text{MnO}_4^-$  has no d electrons, yet it is a very deep purple color. Briefly explain how this is possible, and sketch a very simple M.O. energy level diagram to illustrate your point. (20)