1 Draw the molecular structure and determine the point group for each of the following species 10%

(a) PF_3Cl_2 (b) POF_3 (c) Al_2Br_6 (gas phase) (d) $Fe(C_5H_5)_2$(staggered) (e) $[ReH_9]^{2-}$

2. The point group of trigonal bipyramid $Fe(CO)_5$ is D_{3h}. The character table of D_{3h} is shown below. 10%

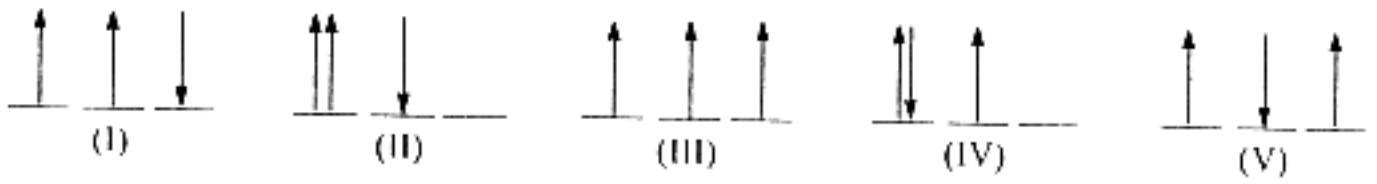
D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1		x^2+y^2, z^2
A_2'	1	1	-1	1	1	-1		
E'	2	-1	0	2	-1	0	(x,y)	(x^2-y^2,xy)
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	z	
E''	2	-1	0	-2	1	0		(xz,yz)

(a) What are the traces of the reducible representation for the five Fe-C σ orbitals?

(b) What are the irreducible representations for the five Fe-C σ orbitals?

(c) Determine what atomic orbitals of Fe are allowed by symmetry to be used in the construction of σ hybrid orbitals.

3 Consider the following possible electron arrangements for a p^3 configuration. 10%



(a) Which of these represents the ground state? Determine the term symbol for the ground state

(b) Which is impossible state?

(c) In which configuration would exchange energy be maximized?

(d) In which configuration would columbic repulsion be maximized?

(e) Determine the number of microstates for a p^3 configuration.

4 Choose and explain: 24%

(a) Which has no mismatch of the sign of the wave function in the π system?

$(PNCl_2)_4$ or $(PNCl_2)_3$

(b) Which is the more stable complex?

$[O_2^+][PtF_6]^-$ or $[N_2^+][PtF_6]^-$

(c). Which has less intensity of d-d transition in visible range?

$[Fe(H_2O)_6]^{2+}$ or $[Mn(H_2O)_6]^{2+}$

(d). Which will exhibit the greater *polarizing power*?

Ti^{2+} or Ti^{4+}

(e) Which has the higher boiling point?

$Ni(CO)_4$ or CCl_4

(f) Which has the higher energy Cr-C stretching bands in the infrared spectrum?

$[Cr(CO)_5(PF_3)]$ or $[Cr(CO)_5(PCl_3)]$

(背面仍有題目,請繼續作答)

5 $[Fe(phen)_2(SCN)_2]$ behaves as a spin-crossover complex, below Tc (critical temperature) only the low spin phase is present and above Tc only the high spin phase is present. 16%

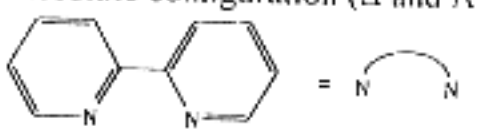
(a) What is the main driving force in spin crossover transformation?

(b) What is relationship between the crystal field splitting energy (Δ_o) and the main spin pairing energy (Π)?

(c) What is the electron configuration for the high spin phase?
What is the spin-only effective magnetic moment (μ_{eff}) for the high spin phase?
Calculate the LFSE for the high spin phase.

(d) What is the electron configuration for the low spin phase?
What is the spin-only effective magnetic moment (μ_{eff}) for the low spin phase?
Calculate the LFSE for the low spin phase.

6 Draw out all the isomers (geometric isomers, and enantiomers) for $[Co(bipy)(NH_3)_2Cl_2]^+$. Assign the absolute configuration (Δ and Λ) of the enantiomers 10%

bipy =  = N N

7. Predict the geometries of the complexes which result from the following reactions 6%

(a) $[Pt(NO_2)Cl_3]^{2-} + NH_3 \rightarrow [Pt(NO_2)(NH_3)Cl_2]^- + Cl^-$

(b) *cis*-$[Pt(RNH_2)_2(NH_3)(NO_2)]^+ + Cl^- \rightarrow [Pt(RNH_2)(NH_3)(NO_2)Cl] + RNH_2$

8 Arrange the following in order of increasing rate of water exchange 4%

$[V(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{3+}$, $[Mg(H_2O)_6]^{2+}$

9 Predict whether these complexes would be labile or inert and explain your choices 6%

(a) Potassium hexaiodomanganate(IV)

(b) Potassium hexacyanoferrate(III)

10 Which of the following obey the 18-electron rule? 4%

(a) $Fe(CO)_5$

(b) $[Rh(bipy)_2Cl]^+$

(c) $(Cp^*)ReO_3$

(d) $Os(CO)(\equiv CPh)(PPh_3)_2Cl$