1. Give the chemical formula for the names of ligands, commonly used in transition-metal complexes: (a) azide (b) aquo (c) carbonyl (d) nitrosyl (e) en; and then draw simple plausible structures for complexes with the following empirical formula: (f) $(OC)_3Re(PMe_3)$, (g) $(OC)_3Cr(C_6H_5)_2$, (h) $(OC)_2RhCl$, (i) $Mo(CO)_3(NO)_3$ (a-e; 1% each and f-i, 2% each) 13%

2. Choose and explain: 12%

(a) Smaller ν(CO) band in the IR spectrum of $[Fe(CO)_4]^{2-}$ or $[Ni(CO)_4]$.

(b) Longer C-C bond distance for the uncoordinated C_2H_4 molecule or that in $[\eta^2\text{-}(C_2H_4)PtCl_3]^-$.

(c) One or two singlets can be observed in the ^{13}C NMR spectrum of the trigonal bipyramidal complex, $Fe(CO)_5$ at room temperature.

3. 連連看 Which structural information fits which molecule or ions? (10%)

(a) O_2 (b) NO (c) HCN (d) N_3^- (e) $[PCl_4]^-$ (f) $XeOF_4$

(i) It is paramagnetic with one unpaired electron.
(ii) It is isoelectronic and isostructural with CO_2, although it is an ion.
(iii) It has only a double bond.
(iv) It has four C_3 symmetrical axes.
(v) It is very toxic and linear.
(vi) It increases more weight than any other species when an external magnetic field is present.

Please use the following format:
Answer: (a)-____ (b)-_____ (c)-_____ (d)-____ (e)- _____(f)-_____ in your answer sheet.

4. Give "yes" or "no" for each of the following complexes to show that it has probably the Jahn-Teller distortion: (a) $Cu(OH_2)_6^{2+}$ (b) $Fe(NH_3)_6^{3+}$ (c) $Cr(CN)_6^{4-}$ (d) $Mn(OH_2)_6^{2+}$ (e) $CoCl_4^{2-}$ (答錯倒扣) (5%)

5. Assume that, in another universe, the values of the quantum number, m_l, are limited to zero or positive integers up to the value of l for a particular subshell; thus for $l = 2$, m_l could be 0, 1, or 2. Describe the electron configuration of nitrogen and that of Ni^{2+}. How many unpaired electrons would be contained in N and Ni^{2+}? What are the ground-state terms for N and Ni^{2+} (10%)

6. Draw the structures of the following: (6%) (a) $BeCl_2$ (crystal) (b) B_4H_{10} (c) $P_3O_{10}^{5-}$

7. Choose and explain: (12%)

(a) Larger bond angle: NO_2 or NO_2^-.

(b) Stronger Lewis base: $(CH_3)_2O$ or $(SiH_3)_2O$.

(c) More soluble in water: LiF or LiI.

8. Explain each of the following: (20%)

(a) $Mn(OH_2)_6^{2+}$ is much less intensely colored than $Cr(OH_2)_6^{2+}$ or $Fe(OH_2)_6^{2+}$.

(b) In aqueous solution, the order of base strength is $Me_2NH > MeNH_2 > Me_3N > NH_3$.

(c) Pure iodine is purple in color as is its solution in CCl_4. Solutions of iodine in acetone and diethyl ether are brown.

(d) Two separate water exchange rates are found for $Cu(OH_2)_6^{2+}$ in queous solution.

9. Find the number, and symmetry species, of the infrared and Raman active vibrations of *trans*-N_2F_2 (C_{2h}). (6%)

C_{2h}	E	C_2	i	σ_h		
A_g	1	1	1	1	R_z	x^2, y^2, z^2, xy
B_g	1	-1	1	-1	R_x, R_y	xz, yz
A_u	1	1	-1	-1	z	
B_u	1	-1	-1	1	x, y	

10. The reaction of $V(CO)_5(NO)$ with $P(OMe)_3$ to give $V(CO)_4\{P(OMe)_3\}(NO)$ has the rate law

$-d[V(CO)_5(NO)]/dt = k_1 [V(CO)_5(NO)] + K_2 [V(CO)_5(NO)][P(OMe)_3]$

Suggest mechanisms for this reaction consistent with the rate law. (6%)