In many transition metal complexes (with high coordination numbers) the bonding can be qualitatively illustrated as a combination of (i) \( n \) M-L antibonding orbitals, (ii) \( 9-n \) non-bonding orbitals, and (iii) \( n \) M-L bonding orbitals, where \( n \) is the number of ligand SALCS and there are 9 total metal-based orbitals (5-d’s + 3-p’s + 1-s) to consider. (a) Why are there \( 9-n \) nonbonding orbitals? (b) What are the nonbonding orbitals for octahedral and tetrahedral complexes?

(2) Construct the molecular orbital diagrams for (a) tetrahedral (\( \text{MH}_4 \)) and (b) octahedral (\( \text{MH}_6 \)) complexes.

(3) Compare and contrast the differences between \( \pi \)-donor and \( \pi \)-acceptor ligands. Give an example of each ligand type.

(4) Compare and contrast the differences between \( \sigma \)-donors and \( \pi \)-donor/acceptor ligands. Give appropriate examples of each ligand and use partial molecular orbital diagrams to support your argument.

(5) For what electronic configurations would you expect strong Jahn-Teller distortion to be favorable?

(6) For the following complex ions determine (a) the number of unpaired electrons, (b) the spin-only effective magnetic moment, and (c) the ligand field stabilization energy.

(i) \( [\text{Co(NO}_2\text{)}_6]^{4-} \)  (ii) \( [\text{Fe(OH}_2\text{)}_6]^{3+} \)  (iii) \( [\text{RhF}_6]^{3-} \)  (iv) \( [\text{Zn(en)}_3]^{2+} \)  (v) \( \text{Cr(CO)}_6 \)

(7) Inspection of the Spectrochemical Series reveals an interesting but surprising trend for halide ligands. It is found that for halides, the ligand field strengths are:

\[ \text{F}^- > \text{Cl}^- > \text{Br}^- > \text{I}^- \]

Explain why this is the case. Hint: It may prove useful to draw a simple molecular orbital diagram for each M-X.