1. Explain why halide ions (e.g., F\(^-\), Cl\(^-\), Br\(^-\), I\(^-\)) function only as *monodentate* ligands in coordination compounds even though halide ions contain four unshared pairs of electrons.

2. The complex ion, [VOFCl\(_2\)Br\(_2\)]\(^-\), has a square pyramidal structure. A diagram illustrating how the square pyramidal structure is oriented in a cartesian axis system is shown below. Draw the structure(s) of *all geometric and optical isomers* that can exist for this complex ion. Label each structure as either a “geometric isomer” or as an “optical isomer”.

![Diagram showing square pyramidal structure]

3. Some old weather forecasting devices utilized the following reaction,

\[
[\text{Co(OH}_2\text{)}_6]^{2+}(aq, \text{pink}) + 4\text{Cl}^- (aq, \text{colorless}) \iff [\text{CoCl}_4]^{2-}(aq, \text{dark blue}) + 6\text{H}_2\text{O}(l, \text{colorless})
\]

These devices were used to predict rain - if the device showed a pink color, then rain was imminent; if the device showed a blue color, then rain was not in the forecast.

Draw the crystal field splitting diagrams for both [Co(OH\(_2\))\(_6\)]\(^{2+}\) and [CoCl\(_4\)]\(^{2-}\) using the following information, and determine how many unpaired electrons exist in each ion.

- H\(_2\)O is a strong-field ligand
- Cl\(^-\) is a weak-field ligand
- [Co(OH\(_2\))\(_6\)]\(^{2+}\) has an octahedral structure whereas [CoCl\(_4\)]\(^{2-}\) has a tetrahedral structure
4. The complex ion, $[\text{VOCl}_4]^2-$, has a square pyramidal structure. Consider the orientation of the complex ion in a cartesian coordinate system as shown below.

\[ Z \]
\[ x \]
\[ y \]

\[ \bigcirc = \text{V} \quad \bigcirc = \text{Cl} \quad \circ = \text{O} \]

a. Draw the crystal field splitting diagram for the complex ion, $[\text{VOCl}_4]^2-$.

b. Predict whether the $[\text{VOCl}_4]^2-$ complex ion will be diamagnetic or paramagnetic. *Note: the oxidation number of the “O” group is -2.*