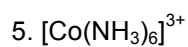
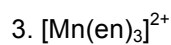
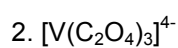
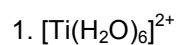


Part A: d-orbital Splitting in Coordination Compounds

1. For each of the following, sketch the d-orbital energy diagram and fill the diagram with d electrons. Determine the number of unpaired electrons, whether the complex is high-spin or low-spin, and label whether the complex is paramagnetic or diamagnetic.



The $[\text{FeCl}_6]^{3-}$ ion is more paramagnetic than $[\text{Fe}(\text{CN})_6]^{3-}$. Can you explain?

Part B: Absorption of Light

2. Estimate the Crystal Field Splitting Energy (Δ_o) for a blue solution of $[\text{Cu}(\text{NH}_3)_6]^{2+}$. The maximum absorption wavelength (λ_{max}) is 615nm.

Use $\Delta_o = E = hc/(\lambda_{\text{max}})$ where $h = 6.62608 \times 10^{-34}$ J sec and $c = 2.997925 \times 10^8$ m/sec

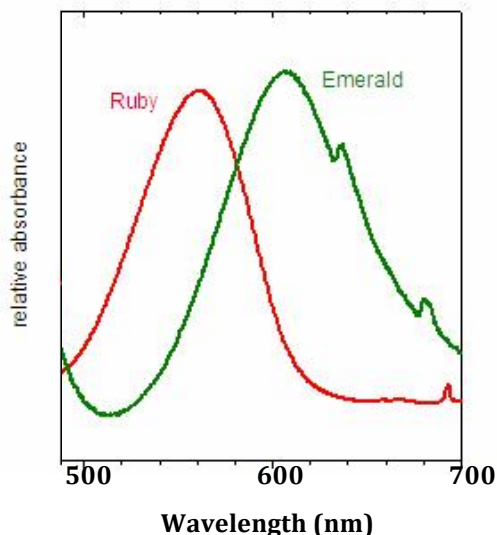
3. You made a sample containing Fe^{2+} and it is light blue-green.

a) Based on the color, do you expect the sample to be low-spin or high-spin?

b) What kind of experiment could you do to figure this out (hint: draw the d-orbital splitting diagram)

4. An aqueous solution of Ni^{2+} is green but Zn^{2+} is colorless. Draw the d-orbital diagrams and fill with d electrons. Once the diagrams are drawn, can you explain why Zn^{2+} is not colored?

5. Below are pictures of a ruby (red) and an emerald (green). A ruby is an aluminum oxide (Al_2O_3) and an emerald is a beryllium aluminosilicate ($\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$). Both contain trace amounts of Cr^{3+} ions, which is the reason the gems are colored. Using the visible spectra to the right, calculate the Crystal Field Splitting Energies (Δ_o) for both the ruby and emerald. Which gem absorbs the lowest energy? Can you explain in terms of the color wheel?



Use $\Delta_o = E = hc/(\lambda_{\text{max}})$ where $h = 6.62608 \times 10^{-34}$ J sec and $c = 2.997925 \times 10^8$ m/sec

6. The complex ion $[\text{Co}(\text{CO}_3)_3]^{3-}$ is an octahedral complex with bidentate carbonate ions as ligands. It has one absorption band in the visible region of the spectrum at 640nm.

- Predict the color of the complex.
- What is the energy associated with this wavelength of light?
- Based on your answer, is carbonate ion a weak or strong field ligand? Is the C or O bound to the Co^{3+} ion?
- Is $[\text{Co}(\text{CO}_3)_3]^{3-}$ paramagnetic or diamagnetic?