The tetrahedral tetrachlorocobaltate(II) salts are an excellent contrast to the octahedral complexes of cobalt(III). Their preparation utilizes large counterions to crystallize the complex from a weakly coordinating solvent.¹ The synthesis of tetrachlorocobaltate(II) salts again begins with CoCl₂·6H₂O:

\[
2 \text{NEt}_4\text{Cl} + \text{CoCl}_2\cdot6\text{H}_2\text{O} \rightarrow (\text{NEt}_4)_2\text{CoCl}_4 + 6\text{H}_2\text{O}
\]

Dissolve 2.6 g NEt₄Cl·H₂O in 30 mL absolute ethanol. Add a solution of 1.78 g CoCl₂·6H₂O in 35 mL absolute ethanol. The desired compound crystallizes at this stage as a blue precipitate. Heat the solution to ~ 50 ºC, adding more ethanol if necessary to obtain a clear solution. Slowly cool to crystallize the compound as deep blue crystals. Collect the crystals with a sintered glass filter (a Buchner funnel is alright but use two pieces of filter paper). Analyze the product by FTIR and UV-Vis (prepare 16 mg in 25 mL acetonitrile) spectroscopy, calculate the extinction coefficient of the complex and the percent yield.

Questions:
1) Determine the spectrochemical series for the ligands used in this experiment. How does this compare with crystal field theory?
2) Why is ethanol used instead of water as the solvent?
3) Is your product paramagnetic? If so, how many spins are there? What is the calculated magnetic moment?
4) How would your UV-Vis spectrum change if the halide ligand was instead Br⁻?

References