系所： 化學系   科目： 無機化學與分析化學

I. (分析部分，50 分)

Answer the following questions

1. (a) What is the **molar concentration** of K^+ in a solution that contains 63.3 ppm of $K_3Fe(CN)_6$ (FW 329.3 g/mol)? **(5%)**
   (b) Calculate the **analytical** and **equilibrium molar concentrations** of the solute species in an aqueous solution that contains 285 mg of trichloroacetic acid (MW 163.4 g/mol), in 10.0 mL (the acid is 73% ionized in water). **(10%)**

2. The solubility product Ksp for the silver salt AgX is 4.0 $(\pm 0.4) \times 10^{-8}$, and the molar solubility is 2.0×10^{-4} M, solubility = $(Ksp)^{1/2} = (4.0 \times 10^{-8})^{1/2} = 2.0 \times 10^{-4}$ M, What is **the uncertainty** in the calculated solubility of AgX? **(5%)**

3. (a) Name three types of **systematic errors**. (b) Describe the ways to detect **systematic errors**. **(10%)**

4. The standard addition method was used in the determination of phosphate by the molybdenum blue method. A 2.00 mL urine sample was treated with molybdenum blue reagents to produce a species absorbing at 820 nm, after which the sample was diluted to 100.00 mL. A 25.00 mL aliquot gave an instrument reading of 0.428. Addition of 1.00 mL of a solution containing 0.0500 mg of phosphate to a second 25.0 mL aliquot gave an absorbance of 0.517. Use these data to calculate **the concentration of phosphate** in milligrams per mL of the sample. Assume that there is a linear relationship between absorbance and concentration and that a blank measurement has been made. **(5%)**

5. List general properties of **activity coefficients**. **(5%)**

6. Which has the **greater buffer capacity**: (a) a mixture containing 0.100 mol of NH_3 and 0.200 mol of NH_4Cl or (b) a mixture containing 0.0500 mol of NH_3 and 0.100 mol of NH_4Cl? Explain your answer. **(5%)**
   Ka for NH_4^+ is 5.7×10^{-10}

7. Sulfide ion forms precipitates with heavy metal cations that have solubility products that vary from 10^{-10} to 10^{-90} or smaller. In addition, the concentration of S^{2-} can be varied over a range of about 0.1 M to 10^{-22} M by controlling the pH of a saturated solution of hydrogen sulfide. These two properties make possible a number of useful cation separations. For example, cadmium sulfide is less soluble than thallium(I) sulfide. Find **the $[H_3O^+]$ conditions** under which Cd^{2+} and Tl^+ can, in theory, be separated quantitatively with H_2S from a solution that is 0.1 M in each cations. **(5%)**
   K_{sp} for CdS is 1×10^{-27}, K_{sp} for Tl_2S is 6×10^{-22}
   K_1 for H_2S is 9.6×10^{-8}, K_2 for H_2S is 1.3×10^{-14}

II. (無機部分，50 分)

1. Calculate the spin-only magnetic moment for the following ions **(6%)**

   (a) Ti^{2+}

   (b) Cr^{2+}

2. Draw the facial and meridional isomers of $[Co(NH_3)_3Cl_3]$ **(4%)**

3. Explain the effect on the d orbital energies when an octahedral complex is compressed or elongated along the z axis. **(7%)**

4. Is the reaction of $[Co(NH_3)_6]^{3+}$ + $[Cr(H_2O)_6]^{2+}$ likely to proceed via an inner-sphere or outer-sphere mechanism? Explain your answer. **(6%)**

5. Construct the molecular orbital diagram of O_2 and predict its magnetic properties. **(6%)**

6. Determine the point group of the following compounds **(6%)**

   (a) C_2H_4 (ethylene)

   (b) C_6H_6 (benzene)

   (c) H_2O

7. Give Lewis structures and sketch the shapes for the following **(9%)**

   (a) SF_6

   (b) SeF_4

   (c) ICl_3

8. Using Crystal Field Theory to sketch the metal d orbital splitting for **(6%)**

   (a) trigonal bipyramidal

   (b) square planar complexes.