PART I. ORGANIC CHEMISTRY (50%)

1. (4%) Draw the Lewis structure and Kekule structure for acetaldehyde

2. (6%) In an ethylene molecule there is a C = C double bond. What is a double bond? Using orbital hybridization, explain how the C = C double bond is formed.

3. (16%) Please give one example and its corresponding IUPAC name (in English) for each of the following family names --
   a. Alkyne b. Ether c. Amine d. Nitrile e. Thiol f. Ketone g. Carboxylic Acid h. Ester

4. (4%) What are Lewis acids and Lewis bases? Please explain with a chemical reaction which involves a Lewis acid and a Lewis base.

5. (6%) Without using any instruments, explain how, by using simple chemical reagents, you can distinguish the following pairs of compounds --
   a. Cyclohexane and benzene b. acetaldehyde and acetone c. n-Butyl alcohol and t-Butyl alcohol

6. (14%) Write complete chemical equations, each with full molecular structures, reagents, products and catalyst (if needed), for the following reactions. (Items in parentheses are either solvents or catalysts) (2% each)
   a. 1-Methylcyclohexene + HBr (ether) ---> ?
   b. 3-Methyl-1-pentene + $KMnO_4$ (H_2O) ---> ?
   c. 1-Pentyne + H_2O (H_2SO_4, $HgSO_4$) ---> ?
   d. Conversion from Benzene to Acetophenone
   e. n-Butylbenzene + $KMnO_4$ (H_2O) ---> ?
   f. Cyclohexanone (NaOH, ethanol) ---> ?
   g. Reduction of n-Butanal to 1-Butanol

PART II. ANALYTICAL CHEMISTRY (50%)

1. (20%) Answer the the following questions (3% each, except question "g")
   a. What is a primary standard? Please give two examples.
   b. What are the criteria for chooing a primary standard?
   c. What are systemic errors? Please give two examples.
   d. What is the difference between the equivalent point and the end point in a titration?
   e. What is the difference between the analytical molarity and the equilibrium molarity?
   f. What is the common-ion effect? Explain with an example.
   g. What is a thermodynamic equilibrium constant? (2%)

2. (10%) A solution of sodium thiosulfate ($Na_2S_2O_3$) was standardized by dissolving 0.1210 g of KIO_3 (fw = 214.00g, purity 98.00%) in water, adding a large excess of KI, and acidifying iwth HCl. The liberated iodine required 41.64 mL of the thiosulfate solution to decolorize the blue starch/iodine complex. Calculate the molarity of the $Na_2S_2O_3$ solution.

3. (10%) Calculate the theoretical potential for the cell
   Ag|AgCl(saturated),HCl(0.0300 M)|H2(0.900 atm),Pt
   The half-reactions for AgCl is
   $AgCl(s) + e^- = = Ag(s) + Cl^-$ $\quad E^\circ = 0.222$ V

4. (10%) Calculate the pH of a solution that is 0.300 M in NH_3 and 0.400 M in NH_4Cl. The base dissociation constant for NH_3 is 1.76×10^{-5}.