1. (2% for each) Name the following compounds:
   a) MnO_2 _____
   b) $NiCO_3$ _____
   c) NH_4ClO_4 _____
   d) B_4H_4 _____
   e) $K_3Fe(CN)_6$ _____

2. Draw structure (4%) and determine the point group of the SOF_4 compound.(4%)

3. The reaction $A \rightarrow B + C$ is known to be zero order in A with a rate constant of 5.0×10^{-2} at 25°C. An experiment was run at 25°C where $[A]_0 = 1.0 \times 10^{-3}$ M. (a) Derive the integrated rate law (4%) (b) Determine the half-life for the reaction. (4%)

4. (9%) Following the values of K_p at different temperatures for the reaction.
   $2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$
   At 800K, $K_p = 9.1 \times 10^2$; at 900K, $K_p = 4.2 \times 10^1$; at 1000K, $K_p = 3.2$; at 1100K, $K_p = 0.39$; and at 1170K, $K_p = 0.12$. Determine ΔH° for this reaction.

5. The wavefunction of 1s orbital for the hydrogen atom is
   $\Psi_{1s} = C(\frac{1}{a_0})^{3/2} e^{-r/a_0}$ (a) Find the value of C that normalizes the orbital (5%)
   (b) Calculate the average distance $< r >$ between the nucleus and electron in terms of a_0. (5%) (c) Calculate the most probable distance r to find the electron in terms of a_0. (5%) [Note: $I_n = \int_0^\infty e^{-ar} r^n dr = \frac{n!}{a^{n+1}}$]

6. Describe the S_N1 and S_N2 mechanisms for nucleophilic aliphatic substitution (R-W + :Z → Z-R + :W) including the detailed mechanisms with the structure of intermediate/transition state (4%), and compare their characterizations of kinetics, stereochemistry, and rearrangement (6%).

7. Why the predominant product of dehydrohalogenation from 2-hexyl halide depends on the halide group? (4%)

8. Define and give an example of each of the following:
   (a) addition polymer (3%)
   (b) condensation polymer (3%)
   (c) Diels-Alder reaction (3%)
   (d) Michael addition (3%)

9. What are the four major categories of spectrochemical methods? (4%) What are their concentration relationships with the measured radiant power? (4%)

10. Differentiate the following pairs:
   (a) scanning tunneling microscope v.s. atomic force microscope (4%)
   (b) size exclusion chromatography v.s. supercritical-fluid chromatography (4%)
   (c) potentiostatic coulometry v.s. amperostatic coulometry (4%)
   (d) thermogravimetric analysis v.s. differential scanning calorimetry (4%)