1. Briefly answer the following questions. (*15%*)

   (a) Name the three compounds, N_2O_5, $C_2H_4O_2$ and Hg_2Cl_2 in English.

   (b) Draw the chair conformation of β-D-Glucopyranose.

   (c) Draw the chemical linkage in the backbone of a protein molecule.

2. The following questions are related to the O_3 molecule. (*15%*)

   (a) Draw its Lewis structure. (*6%*)

   (b) According to the VSEPR model, predict the molecular geometry. (*3%*)

   (c) What is the hybridization around the central atom? (*3%*)

   (d) Calculate the formal charges for the 3 oxygen atoms. Indicate the answer on the molecular structure of (a). (*3%*)

3. The following questions are related to thermodynamics. (*15%*)

   (a) Define an isolated thermodynamic system. (*3%*)

   (b) Define a state function in thermodynamics. (*3%*)

   (c) Describe the first law of thermodynamics. (*3%*)

   (d) Define $\Delta_f H^o_i$, the standard enthalpy of formation of a compound *i*, and describe how to calculate $\Delta H^o_{reaction}$, the enthalpy change for a given reaction based on the $\Delta_f H^o_i$ of the participating substance with known stoichiometric coefficient v_i. (*6%*)

4. The following questions are related to quantum mechanics. (*20%*)

   (a) Write the time-independent Schrödinger equation for a one-particle, one-dimensional system. Define all the terms in the equation. (*8%*)

   (b) A series of quantum numbers are used to characterize the wave functions obtained when solving the Schrödinger equation for the hydrogen atom. Describe the respective physical meanings of the angular momentum and the magnetic quantum numbers. (*6%*)

   (c) Define degenerate orbitals and give an example. (*6%*)

5. (a) Write the Arrhenius equation and define all the terms of the equation. (*7%*)

   (b) Design an experiment to determine the activation energy of the following reaction.

   $$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

   Include the experimental procedure and data treatment in your answer. (*8%*)

6. A Galvanic cell consists of cathode A and anode B. The standard electrode potentials of the following two half reactions are denoted as $E^o_{A^{2+}/A}$ and $E^o_{B^{3+}/B}$, respectively. (*20%*)

$$A^{2+}(aq) + 2e^- \rightleftarrows A(s) \qquad E^o_{A^{2+}/A}$$

$$B^{3+}(aq) + 3e^- \rightleftarrows B(s) \qquad E^o_{B^{3+}/B}$$
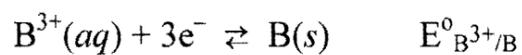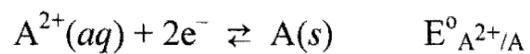
(a) Describe the experimental method for the determination of $E^o_{A^{2+}/A}$ and $E^o_{B^{3+}/B}$. (*7%*)

(b) Write the balanced cell reaction. (*3%*)

(c) Derive the equilibrium constant for the cell reaction of (b). (*10%*)