1. Write down the atomic structure of chlorine (atomic number=17). (5%) 

2. How many electrons are in 0.01 g of gold (atomic weight=196.97, atomic number=79)? (10%) 

3. A particular weak solution of acetic acid (HC₂H₃O₂) in water has the ionic concentrations (in unit of moles/liter) given below. What is the equilibrium constant? (10%) 

   \[ \text{HC}_2\text{H}_3\text{O}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{C}_2\text{H}_3\text{O}_2^- \]

   \[ [\text{HC}_2\text{H}_3\text{O}_2] = 0.09866; [\text{H}_2\text{O}] = 55.5555; [\text{H}_3\text{O}^+] = 0.00134; [\text{C}_2\text{H}_3\text{O}_2^-] = 0.00134 \]

4. (a). Define the enthalpy of reaction. (5%) 
   (b). Using enthalpies of formation, calculate the standard heat of stoichiometric combustion of gaseous methane and oxygen. The standard enthalpies of formation (in unit of kcal/mol) for each species are \( \Delta H_f \text{ H}_2\text{O} = -57.8; \Delta H_f \text{ CH}_4 = -17.9; \Delta H_f \text{ CO}_2 = -94.05; \Delta H_f \text{ O}_2 = 0 \) (10%) 

5. Define and give an example for each of the following terms. (40 %) 
   (a) Lewis acid and base 
   (b) S₅2 reaction 
   (c) S₅1 reaction 
   (d) Resonance hybrid 
   (e) Functional group 
   (f) Catalysts 
   (g) Crystal 
   (h) Polymerization 

6. Propose a mechanism for the acid-catalyzed reaction of acetaldehyde with ethanol to give acetaldehyde diethyl acetal. (10 %) 

   \[ \begin{array}{c} \text{CH}_3\text{C}=\text{O} + 2\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{H^+} \text{CH}_3\text{CH}_2\text{OCCH}_3 + \text{H}_2\text{O} \\ \text{acetaldehyde} \hspace{1cm} \text{ethyl alcohol} \hspace{1cm} \text{acetaldehyde diethyl acetal} \end{array} \]

7. Spectroscopy is an important technique for identification and quantification of species in analytical chemistry. (a) State the principle of absorption spectroscopy for quantification. (2 %) (b) What is the effect of UV-vis and IR absorptions on molecules? (4 %) (c) What information can we obtain from UV-vis and IR spectroscopy, respectively? (4 %)