Undergraduate Programme, 2025
Semester-II (UGNEP)
Chemistry Major
Paper: MJCH03: Gr. A&B
Inorganic (Theory)

Time: Three Hours **Full Marks: 80**

(Use separate answer scripts for each group)

Questions are of value as indicated in the margin

Group –A (Marks: 40)
(Inorganic Chemistry)

*Answer **any four** of the following questions*

1. (a) Define disproportionation and comproportionation reactions with suitable examples
   (b) Metallic aluminium turns sodium nitrate into ammonia in the presence of sodium hydroxide. Balance the reaction involved by the ion-electron method.
   (c) Differentiate between an electrolytic cell and a galvanic cell. Give an example in each case.
   (d) Describe briefly: (i) Dry cell and (ii) Storage cell.
   (e) What is the standard electrode potential? Mention the factors controlling it. (1+1)×5=10

2. (a) Write the basic assumptions of the Liquid Drop Model.
   (b) Write the semi-empirical mass formula, mentioning the name of each energy term.
   (c) What are magic numbers, and why are they important in nuclear chemistry?
   (d) Write the nuclear configurations of $^{39}_{19}K$. 3+3+2+2=10

3. (a) What is the EMF of a cell? Derive the Nernst equation for the EMF of a chemical cell.
   (b) The standard EMF of a Daniell is 1.1V at 25°C. Calculate the equilibrium constant of the reaction occurring in that Daniell cell at 25°C. Also, calculate the standard free energy change and the electrical work done by the cell.
   (c) What do you mean by Latimer diagram? Give an example. Mention the utility of the Latimer diagram. (1+2)+(1+1+1)+(1+1+2)=10

4. (a) What is the life of a radioactive element? Write its expression.
   (b) The $^{3}_{1}H$ isotope of hydrogen, tritium, has a half-life of 12.33 yr. It is produced in the upper atmosphere by cosmic rays and brought to Earth by rain. As an application, determine approximately the age of a bottle of wine whose $^{3}_{1}H$ radiation is about $\frac{1}{10}$ that present in new wine.
   (c) Write the Soddy-Fajan group displacement law (s) with an example (s).
   (d) Arrange alpha (α), beta (β), gamma (γ) radiations according to their (i) penetrating and (ii) ionizing power. 2+3+3+2=10

5. (a) How do the following two compounds differ in their aqueous solutions in terms of the ions present: $KAl(SO_4)_2.12H_2O$ and $CuSO_4.4NH_3$
   (b) How do the following compounds differ during their reaction with $AgNO_3$ and why?
   i) $CoCl_3.\ 6NH_3$ ii) $CoCl_3.\ 5NH_3$; iii) $CoCl_3.\ 4NH_3$ 4 +6 = 10

6. (a) Write the three geometrical possibilities for a complex of coordination number six, and which one exists in the said complex. Explain.

(b) If you add $CuSO_4$ in concentrated NH_3 and, on other occasions, in dilute NH_3, where do you find a Cu-complex, and why?
(c) What do you mean by ligands, and give an example of a bidentate ligand? 4 + 4 + 2 = 10

Group –B (Marks: 40)
(Physical Chemistry)

Unit-I

Answer **any two** questions

1. (a) How many independent variables are required to define a state of a thermodynamic system with one component? Explain the answer with a suitable example. Generalize the answer for a thermodynamic system with N components. If the composition of this system is kept fixed then how many independent variables are required to define the state of the same? 2+3+1
   (b) What is the caloric theory? Is it true? Justify the answer. 1+3

2. (a) Define reversible and irreversible processes with suitable examples. What are the differences between the two processes? Both the processes are real. Comment on the statement. 4+2+1
   (b) A finite transformation of a system may be a reversible or an irreversible one. Comment on the statement with suitable examples. 3

3. (a) Prove that $PV\gamma=C$ for adiabatic reversible expansion of an ideal gas. compare this result with the isothermal reversible expansion of the same. Give answer using the P-V plot. Point out significant differences (if any) with explanation. 4+3
   (b) One mole of an ideal gas having and initially at 25^0C and 100 KPa, is compressed adiabatically using a constant pressure equal to the final pressure until the temperature of the gas reaches 325K . Calculate the final pressure. 3

4. State and prove the Clausius inequality. What is the significance of this relation? Apply this relation for spontaneous transformation of an isolated system and characterize the entropy. What is the Clausius statement on the entropy of an isolated system. Justify the relations, $ds\geq 0$ with suitable examples. 1+2+2+1+4

Unit-II

Answer **any two** questions

5. (a) Discuss how the equivalent conductance of weak and strong electrolytes varies with dilution. 2+2
   (b) A conductivity cell filled with 0.1M solution of KCl at 25 ^{0} C has a measured resistance of 24.96 ohm. Calculate the cell constant if the specific conductance of 0.1M KCl solution be 0.011639 ohm $^{-1}$ cm $^{-1}$ and conductivity water of L s = 7.5×10^{-8} ohm $^{-1}$ cm $^{-1}$ is used to make up the solution. When the cell is filled with a 0.001M solution of acetic acid, the cell resistance becomes 1982 ohm. Calculate the molar conductivity of acetic acid at this concentration. 3
   (c) Explain how by a graphical method the equivalent conductance of a weak electrolyte at infinite dilution can be determined. 3

6. (a) Discuss how the factors like viscosity, dielectric constant and temperature affect the electrophoretic effect and the relaxation effect. 3
   (b) Briefly discuss Debye-Falkenhagen effect and Wien's effect as evidence of Debye-Hückel ion atmosphere model. 2+2
   (c) Derive the following relation related to the terminal speed of an ion in an electrolyte solution:
   $\nu = \nu_T (1 - e^{-6\pi\eta r t/m})$. 3

7. (a) Deduce the following relation known as the Walden's rule
   $\Lambda_m \eta = |e|F(\nu_+ z_+^2/r_+ + \nu_- z_-^2/r_-)/6\pi$. Comment on this relation. Discuss when we observe departures from the above relation. 3+2+1
   (b) H^+ ions do not exhibit abnormal mobility in acetone solvent–comment on the statement. 2
   (c) Define ionic mobility. What is its unit? 1+1

8. (a) Prove that the equivalent conductance of an ion is proportional to its mobility where the proportionality constant is Faraday. 3
   (b) Define transport number. For a single electrolyte solution show that
   $t_+ = i_+/(i_+ + i_-) = \nu_+/(\nu_+ + \nu_-) = u_+/(u_+ + u_-) = \lambda_+/(\lambda_+ + \lambda_-)$. 1+3
   (c) Discuss the nature of the conductometric titration curve when acetic acid is titrated against ammonium hydroxide. 3