B. Sc. (Honours) Examination, 2025
Semester-II (CBCS)
Chemistry (Honours)
Core Course: CC-3 (Back)
(Inorganic and Physical Chemistry)

Time: Three Hours **Full Marks: 60**

(Use separate answer scripts for each group)
Questions are of value as indicated in the margin.

Group-A (Marks: 30)
(Inorganic Chemistry)

Answer **any three** of the following questions

1. (a) In an acidic medium, one mole of ferric oxalate requires x mole of potassium permanganate, whereas one mole of ferrous oxalate requires y nole of potassium permanganate. Determine the relationship between x and y.
(b) Compare the oxidizing power
(i) $CrO_4^{=}$, $FeO_4^{=}$, $MnO_4^{=}$ and (ii) ReO_4^{-}, TeO_4^{-}, MnO_4^{-} .
(c) The Latimer diagram of iron in 1M acid medium is
FeO_4^{2-} ---------> Fe^{3+} (2.2V) --------> Fe^{2+}(0.77V) -------> Fe (-0.44V) Find out the E^0 (Fe^{3+}/Fe) value.
(d) Find out the formal potential of potassium dichromate at pH = 7.
Given E^0 ($Cr_2O_7^{2-}/Cr^{3+}$, H^+ = 1.33V at 25^0C)
(e) Differentiate iodometry and iodimetry with an example. 2+2+2+2+2 = 10

2. (a) What is the life of a radioactive element? Write its expression.
(b) The ${}_1^3H$ 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 ${}_1^3H$ 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

3. (a) Write down the correct formula for the $CoCl_3.6NH_3$ complex and establish the position of the third bracket with the help of Werner's theory.
(b) NH_2-NH_2 acts as a bridging ligand, while NH_2-CH_2-CH_2-NH_2 acts as a bidentate chelating ligand. Explain
6+4=10

4. (a) Sketch an EDTA complex mentioning the primary and secondary valency of the metal.
(b) Why are metal-EDTA complexes very stable?
(c) Give an example of radioisotope. Briefly discuss one utilization of radioisotope.
2.5+2.5+(1+4)=10

5. (a) What is Zimmermann – Reinhardt's reagent? Elucidate the function of each component.
(b) What do you mean by the standard reduction potential? Discuss the controlling factor (s) on its value.
(c) Calculate the mass defect (Δm) and nuclear binding energy (B) and binding energy per nucleon ($\bar{B}$) in MeV of ${}_{\mathbf{26}}^{\mathbf{56}}\boldsymbol{Fe}$. Given m(${}_{26}^{56}Fe$) = 55.934932 u, m_H = 1.00827u and m_n = 1.008665u.

(d) (c) How many alpha and beta particles are emitted when $^{238}_{92}U$ decays to $^{206}_{82}Pb$? (2.5+2.5+3+2) = 10

Group-B (Marks: 30)
(Physical Chemistry)
Unit-I

Answer **any two** questions

1. (a) What do you mean by advancement of reaction? What is its unit?
(b) "The stoichiometry of an elementary reaction indicates the order of the reaction." Justify.
(c) A first order reaction have half-life of 1 hour. Calculate the value of the rate constant? How long it will take to 90% of completion?
(d) "The reactions having order less than one can have finite time of completion."- explain. 2+1.5+2+2

2. (a) Derive the integrated rate law for a first order consecutive reaction $A \xrightarrow{k_1} B \xrightarrow{k_2} C$.
(b) Discuss the concept of pre-equilibrium step and the find the rate law of the following reaction applying the concept $2NO + O_2 \rightarrow 2NO_2$. 4+(1.5+2)

3. (a) The order with respect to concentration n_c is considered as true order rather than order with respect to time n_t.- explain.
(a) The rate of a reaction depends on the temperature- explain using Arrhenius equation?
(b) For a parallel reaction consisting of two first order reaction, the overall rate constant is $k_{obs}=k_1+k_2$. Find the expression of overall activation energy of the reaction. The k_1 and k_2 are rate constants of the two parallel steps. 2.5+2.5+2.5

4. (a) Derive the rate low a unimolecular gaseous reaction according to Lindemann mechanism and show that the order of the reaction changes from second order to first order with increase in pressure.
(b) In the Transition State Theory, show that the rate of the reaction should be equal to the product of frequency of vibration of the bond and the concentration of the activated complex.
(c) What is the significance of the entropy factor in the transition state theory. 4+2+1.5

Unit-II

Answer **any two** questions

5. (a) State the limitation of the first law of thermodynamics with two examples. 3
(b) Prove the Clausius inequality relation and interpret it. Is it applicable for any kind of systems (isolated, closed and open)? Give answer with reason. 2+1+1.5

6. Prove that $\oint(đQ/T) \leq 0$. Symbols have usual meaning. Using this relation prove that coefficient of performance of a real heat pump is less than that of a Carnot heat pump. 5+2.5

7. One mole of oxygen expands adiabatically against a constant external pressure of 1 atm. until the pressure balances. The initial temperature and volume are 200 ºC and 20 lits., respectively. [Assume that gas behaves ideally]
(i) Explain whether the process is reversible or not. 2
(ii) Calculate the final temperature, work done and the change in entropy. 1.5+1.0+1.0
(iii) Will the quantities be different if n moles of oxygen were taken? Give reason. 2

8. Find an expression to determine the change of entropy due to change of temperature and pressure of the system. It is applicable for both the reversible and irreversible processes. Comment on the statement. 5+2.5