(b) Explain surface heterogeneity and its effect on adsorption and catalytic activity. **7.5**

6. (a) Classify types of pores in materials. Discuss porous materials with reference to adsorption behaviour in MOFs and their applications. **7.5**

(b) Discuss ionic mobility and its relation to the diffusion coefficient. Discuss the physical interpretation of the dependence of temperature and viscosity. **7.5**

7. Describe the following with suitable examples :

(a) Competitive and non-competitive inhibition. **5**

(b) Activation energy for surface reactions. **5**

(c) Debye-Hückel-Onsager theory for non-aqueous solutions. **5**

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May 2026

M.Sc. (Chemistry) (Second Semester)

Physical Chemistry (General-II) (CHP-106-V)

Time : 3 *Hours*] [*Maximum Marks :* 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

Part A

1. (a) What is the significance of K_m in enzyme kinetics ? **1.5**

(b) What is the Debye-Hückel reciprocal length ? **1.5**

(c) How do solvent properties (dielectric constant, viscosity) influence ion-ion interactions ? **1.5**

(d) What is the condition for an explosion in a branching chain reaction ? If branching factor > 1.2, predict system behaviour. **1.5**

(e) In the presence of inhibitors, K_m increases from 2.5 mM to 5 mM while V_{max} remains constant. Identify the type of inhibition. (Symbols have their usual meaning). **1.5**

(f) Can we quantitatively estimate the electrolyte's electrophoretic and relaxation effects ? Explain. **1.5**

(g) Comment on the size dependence of ionic mobility using the Stokes-Einstein relation. **1.5**

(h) Nitrogen gas adsorbed on a porous nanomaterial at 77 K, a hysteresis loop is observed. Identify whether the material is microporous or mesoporous and justify. **1.5**

(i) Which equation describes both drift and diffusion potential for a real system ? State the equation and explain all the terms. **1.5**

(i) Write the mathematical expression of the Gibbs-Adsorption equation. What is the physical significance of it and its application ? **1.5**

Part B

2. (a) Explain diffusion potential in electrolyte solutions and derive the Planck-Henderson equation. Discuss its significance for the liquid junction potential with a suitable example. **7.5**

(b) Derive the expression for the Langmuir adsorption isotherm and discuss its limitations. Explain its significance for dissociative adsorption, if applicable. **7.5**

3. (a) Define chain reactions. Explain the mechanism and kinetics of hydrogen-halogen reactions using the steady-state approximation. Comment on the overall reaction order and order of reaction with respect to the steady state species. **7.5**

(b) Derive the rate law for a bimolecular surface reaction and discuss the rate-determining step. **7.5**

4. (a) Explain the steady-state approximation and apply it to derive the rate law for a typical chain reaction using parallel and antiparallel spins of H_2 as an example. **7.5**

(b) Discuss the Onsager phenomenological equations in the context of ion transport. **7.5**

5. (a) Write the Lineweaver-Burk equation and sketch a typical Lineweaver-Burk plot. What are the characteristics of this plot, and explain its physical significance in comparison to the Eadie plot ? **7.5**