November 2025
M.Sc.
First Semester
CORE – 04
CHEMISTRY
Course Code: MCHC 1.41
(Physical Chemistry - II)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Explain the behaviour of ions on the structure of water. 5
   (b) Derive the Debye-Huckel-Onsagar equation for an electrolyte. 5
   (c) Discuss the mean ionic activity coefficient in terms of ionic strength. 4

2. (a) Determine the mean ionic activity coefficient by the solvent vapour pressure method. 5
   (b) Write a note on each of the following: 3×2=6
   (i) Structure of water
   (ii) Ion-ion interactions
   (c) Briefly explain the physical significance of the activity coefficient of an electrolyte. 3

UNIT–II

3. (a) Explain the concept of free energy change due to ion-solvent interactions with an example. 5
   (b) Define overvoltage. Explain its role in irreversible electrode processes and discuss the principle of polarography. 1+4=5
   (c) Write the Tafel equation and explain how it is used to determine the overpotential in electrode reactions. 4

4. (a) Differentiate between polarizable and non-polarizable interfaces in electrochemistry with suitable examples. 4

(b) Derive the basic electrode equation of the Butler-Volmer equation along with its applications. 6

(c) Discuss the electrochemical mechanism involved in the functioning of the nervous system. 4

UNIT–III

5. (a) State and explain the Fick's second law of non-steady state diffusion. 3

(b) Derive the expression for thermal conductivity with respect to diffusion of a gas. 7

(c) What do you understand by diffusion coefficient? Explain. 4

6. (a) Derive the expression for the Nernst-Einstein equation for the diffusion coefficient and equivalent conductivity. 5

(b) Establish the relationship between viscosity and the mean free path of a gas. 6

(c) At what pressure does the mean free path of argon gas at 25°C become comparable to the size of a 1.0 litre vessel that contains it? Assume that $\sigma = 0.36\ nm^2$. 3

UNIT–IV

7. (a) Derive an expression for entropy production and entropy flow in open systems. 6

(b) Explain the Clausius inequality for an irreversible process. 4

(c) Write a note on Onsager reciprocity relation. 4

8. (a) Deduce the expression for the entropy production due to an electrochemical reaction. 6

(b) Explain in detail the generalized forces and fluxes of entropy production. 4

(c) Write the postulates of non-equilibrium thermodynamics. 4

UNIT–V

9. (a) Give the relation between partition function and internal energy. 2

(b) Explain the Debye theory for heat capacity of solids. 5

(c) Discuss the Fermi-Dirac statistics. 5

(d) Briefly explain the different types of ensembles. 2

10. (a) Derive the expression for the molecular translational partition function of an ideal gas. 5

(b) Explain the equilibrium constant in terms of partition functions. 5

(c) What is ensemble averaging? Explain. 4