

**M. SC. (CHEMISTRY)/M. SC.
(ANALYTICAL CHEMISTRY)
(MSCCHEM/MSCANCHEM)**

Term-End Examination

June, 2026

MCH-013 : GENERAL PHYSICAL CHEMISTRY

Time : 2 Hours

Maximum Marks : 50

Note : (i) *Question No. 1 is compulsory.*

(ii) *Attempt any **four** questions from
Question Nos. 2 to 7.*

(iii) *Use the following values wherever
required :*

$$k_B = 1.38 \times 10^{-23} \text{ JK}^{-1};$$

$$h = 6.626 \times 10^{-34} \text{ J-s};$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1},$$

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1};$$

$$1 \text{ cm}^{-1} = 1.98 \times 10^{-23} \text{ J}.$$

1. Attempt any *five* questions from the following : 5×2=10

- (i) What is the salt effect in rate of reactions in solution ?
- (ii) What is the difference between isobaric and isothermal processes ?
- (iii) What are the amorphous materials ?
Give any *two* examples.
- (iv) Describe the lock and key hypothesis of the enzyme action.
- (v) What is the relationship between molecular and canonical partition function ?
- (vi) State the law of constancy of interfacial angles.

(vii) Define coefficient of viscosity of a gas and give the expression for the viscosity coefficient of a gas under laminar flow.

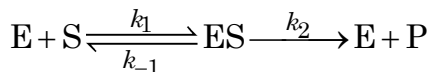
2. (a) What are the random variables ? Name their types. 1+1

(b) Give the expression for rate constant as per Transition State Theory (TST) and name the terms involved. 1+1

(c) Calculate the ionic strength of a solution which is 0.1 molal in KCl and 0.2 molal in K_2SO_4 . 3

(d) The rotational temperature for HI molecule is around 10 K. Calculate the moment of inertia for HI. 3

3. (a) Write the Michaelis-Menten equation for the following enzymatic reaction and define each term involved : 2

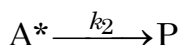
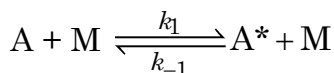


- (b) How does the total entropy of the universe change for reversible and irreversible processes in an isolated system ? 2
- (c) Define molar conductivity. How do we obtain the molar conductivity at infinite dilution ? 2
- (d) Pollonium is assumed to crystallize in primitive cubic unit cell at room temperature. If $a = 0.4$ nm, calculate the theoretical density of pollonium. Molar mass of pollonium is 209 g mol^{-1} . 4

4. (a) Formulate the relationship between mean molality (m_1) and m for following electrolytes : 1+2
- (i) NaCl
- (ii) Na₂SO₄
- (b) Show that in a binary mixture, when the chemical potential of component A decreases then the chemical potential of component B will increase, if the temperature and pressure are fixed. 3
- (c) Describe stoppered flow method in brief, giving a suitable schematic diagram for the same. 2+2
5. (a) Write the expression for adsorption isotherm in terms of equilibrium constant and discuss the variation of fraction of surface uncovered as a function of the concentration (or pressure) of the gaseous adsorbate. 3

- (b) Calculate the temperature at which the average velocity of oxygen equals that of hydrogen at 20 K. [Mass of $O_2 = 32 \text{ g/mol}$]. 3

- (c) Consider the following Lindemann mechanism for the unimolecular decomposition of a molecule A in the presence of a species M :



Using the steady state approximation, derive the rate law for the formation of the product. 4

6. (a) How do we determine the values of R_{max} and K_m from Lineweaver-Burk plot ? 2

- (b) Derive the following relations using appropriate expressions : 2+2

(i) $\left(\frac{\partial A}{\partial T}\right)_V = -S$ or $\left(\frac{\partial A}{\partial V}\right)_T = -P$

(ii) $\left(\frac{\partial G}{\partial P}\right)_T = V$ or $\left(\frac{\partial G}{\partial T}\right)_P = -S$

- (c) Show that the chemical potential of the pure substance is equal to the molar Gibbs energy of the pure substance. 4

Or

Give the physical significance of any *two* of the following :

- (i) Chemical potential
- (ii) Partial molar volume
- (iii) Helmholtz energy
- (iv) Gibbs energy

7. (a) Write any *two* symmetry elements. Give the schoenflies notation for them. 2

- (b) What are the basic assumptions of Debye-Hückel theory ? Give the mathematical expression for the Debye-Hückel limiting law and name the terms involved. 3
- (c) Derive the translational partition function for a particle of mass m , confined into a one-dimensional box of length L , where the energy of the particle is given as : 5

$$\epsilon_{n,\text{trans}} = \frac{n^2 h^2}{8mL^2}$$

× × × × ×