ASSIGNMENT BOOKLET

M.Sc. in Chemistry/Analytical Chemistry Programme (MSCCHEM/MSCANCHEM)

MCH-013: General Physical Chemistry
(Valid from 1st July 2025 to 30th June 2026)

It is compulsory to submit the assignment before filling in the examination form

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THE PEOPLE'S
UNIVERSITY

School of Sciences
Indira Gandhi National Open University
New Delhi-110068
(2026)

Dear Learner,

Please read the section on assignments in the Programme Guide for M.Sc. in Chemistry/Analytical Chemistry that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, which would consist of one tutor-marked assignment for this course. The assignment is in this booklet, and covers both the blocks of the course. The total marks of all the parts are 100, of which 40% are needed to pass it.

Instructions for Formatting Your Assignments

 Before attempting the assignment, please read the following instructions carefully:

1. On top of the first page of your answer sheet, please write the details exactly in the following format:

<div style="text-align:right">

ENROLAMENT NO. :…..………..
NAME :…………………...
ADDRESS :……………………

</div>

COURSE CODE :……………..
COURSE TITLE :……………..
ASSIGNMENT NO :……………..
STUDY CENTRE :……………..   **DATE :…………….**
(Name and Code)

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2. Use only foolscap size paper (but not of very thin variety) for writing your answers.
3. Leave about 4 cm margin on the left, top and bottom of your assignment response sheet.
4. Your answers should be precise.
5. Submit the complete assignment answer sheets within the due date.
6. The assignment answer sheets are to be submitted to your Study centre within the due date. Answer sheets received after the due date shall not be accepted.
   We strongly suggest that you retain a copy of your answer sheets.
7. This assignment is valid from 1st July, 2025 to 30th June, 2026. If you have failed in this assignment or fail to submit it by June 2026, then you need to get the assignment for the year 2027, and submit it as per the instructions given in the Programme Guide.
8. You cannot fill the examination form for this course until you have submitted the assignment.

Wishing you good luck

Course Code: MCH-013
Assignment Code: MCH-013/TMA/2025
Maximum Marks: 100

Note: Attempt all questions. The marks for each question are indicated against it.

1. Answer **any five** of the following in brief. (2×5)

   a) Give the physical significance of Helmholtz energy.

   b) What is the effect of temperature on chemical potential?

   c) Explain the molecular partition function in brief.

   d) What is the improper rotation of the molecules? Explain with a suitable example.

   e) Give the characteristics of the unimolecular reactions.

   f) Define the primary and secondary salt effects on the rate of reactions in solution.

   g) Why the conventional kinetic methods are not useful to study the fast reactions?

2. (a) Determine the conditions for the spontaneity and equilibrium for following combinations of ΔH and ΔS for a given process.

   (i) $\Delta H < 0$ and $\Delta S > 0$

   (ii) $\Delta H > 0$ and $\Delta S < 0$

   (iii) $\Delta H > 0$ and $\Delta S > 0$, and

   (iv) $\Delta S = 0$. (5)

   (b) (i) Two moles of an ideal gas expand isothermally at 300 K from 7 bar to 3 bar. Calculate the change in the Helmholtz energy and Gibbs energy for the process.

   (ii) Define partial molar volume and give its physical significance. (3+2)

3. (a) Give Stirling's approximation and outline its significance. Calculate the % error introduced in computing the value of 10! by using this approximation. (Given ln 2= 0.69 and ln 3= 1.01) (5)

   (b) (i) A system consist of two energy level ϵ_0 and ϵ_1 which are singly and triple degenerate, respectively. Calculate the partition function of the system. (2)

   Or

   Derive the relation between molecular and canonical partition function. (2)

   (ii) Derive an expression for the rotational partition function. (3)

4. (a) (i) Define Tetrahedral and Octahedral voids in three dimensional close packing.

   ii) If atoms of element B form HCP lattice and 2/3rd of tetrahedral voids are occupied by those of the element A,what is the formula of the compound formed by the elements A and B?

   (iii) State the law of constancy of interfacial angles. (2+2+1)

   (b) (i) Show the following planes in cubic unit cells

      i) (110) in Primitive cubic cell

      ii) (111) in Face-centred cubic cell and

      iii) (200) in Body-centred cubic cell.

   (ii) Give the difference between screw Axis and glide Plane by using suitable illustrations.

   or

   Identify all the symmetry elements in *trans* $C_2H_2Cl_2$ or B_2Cl_6 (3+2)

5. (a) Give the salient features of the collision theory and calculate the factor that relates the collision theory with Arrhenius Equation. (5)

(b) (i) Discuss the Lindemann-Christiansen mechanism for unimolecular reactions and give the Hinshelwood's modification of this mechanism.

(ii) What are two important features of the expression for rate of activation as per RRK theory? (3+2)

6. Answer **any five** of the following in brief. (2×5)

a) Give the principle of ultrasonic relaxation methods for the determination of the rates of the fast reactions.

b) Explain the difference between homogeneous and heterogeneous catalysis with suitable examples.

c) Describe the lock and key hypothesis of the enzyme action.

d) What is the role of solvent in the Debye-Huckel model of a solution of an electrolyte?

e) Why did we need the modification in the Debye-Huckel theory?

f) Give the mathematical expressions of any two type of Maxwell and Boltzmann distribution of molecular speeds and name the terms involved.

g) What is the effect of pressure and temperature on thermal conductivity?

7. (a) Derive the expression of the rate constant for reactions in solution in terms of activity where the reference standard state for the reactants is the gaseous state. (5)

(b) (i) What is the difference between diffusion controlled and activation-controlled reactions.

(ii) Discuss the stopped flow method for the study of fast-reactions with suitable schematic diagram and outline its advantages over continuous flow method. (1+4)

8. (a) What is adsorption in homogeneous catalysis? Derive an expression for *Langmuir monolayer adsorption isotherms* for adsorption at sufficiently low concentrations. (1+4)

(b) (i) What is the difference between competitive and uncompetitive enzyme inhibition?

(ii) Derive the mathematical rate expression for competitive enzyme inhibition and give the graphical representation of Lineweaver-Burk plot. (1+3+1)

9. (a) (i) Write the basic assumptions of the Debye-Huckel theory. (2)

(ii) Calculate the ionic strength of

i) 0.08 mol kg^{-1} solutions of $Ca(NO_3)_2$ and

ii) the solution consisting of 6.3 g of $MgCl_2$, 5 g of $AlCl_3$ and 500 g of water. (3)

(b) (i) List different methods of experimental determination of activity coefficients. (2)

(ii) Explain the principle for the experimental determination of activity and activity coefficient from solubility measurements. (3)

10. (a) (i) What are the limitations of phenomenological approach to transport properties? (2)

(ii) Using the Fick's first law of diffusion, derive the mathematical expression that provides the link between the phenomenological and thermodynamic treatment of diffusion phenomenon. (3)

(b) (i) Why is conductivity not a suitable quantity to compare the conduction behaviour of different electrolytic solutions? (2)

(ii) Define thermal conductivity. Why the thermal conductivity of gases is independent of pressure up to a reasonably high pressure. (2)