

MCH-014

ASSIGNMENT BOOKLET

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

MATHEMATICS FOR CHEMISTS
(Valid from 1st July 2026 to 30th June 2027)

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



School of Sciences
Indira Gandhi National Open University
New Delhi-110068
(2026-2027)

Dear Learner,

Please read the section on assignments in the Programme Guide for M.Sc. in 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:

ENROLAMENT NO. :.....

NAME :.....

ADDRESS :.....

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, 2026 to 30th June, 2027. If you have failed in this assignment or fail to submit it by June 2027, then you need to get the assignment for the year 2027-2028, 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

Tutor Marked Assignment

MTMATHEMATICS FOR CHEMISTS (MCH-014)

Course Code: MCH-014

Assignment Code: MCH-014/TMA/26-27

Maximum Marks: 100

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

1. (a) Write down all the subsets of $\{1,2,3\}$. How many of these contain (2)

(i) no element.

(ii) one element.

(iii) two elements.

(iv) three elements.

- (b) Draw a Venn diagram to represent the sets

$$U = \{1, 2, \dots, 10\}, A = \{1, 2, 3, 9\}, B = \{3, 4, 5, 9\}, C = \{6, 7, 9\} \quad (2)$$

- (c) Find the sum up to n terms of the sequence:

$$0.7, 0.77, 0.777, 0.7777 \dots \quad (3)$$

- (d) Expand $\left(\frac{1}{2} + \frac{1}{3}\right)^5$ using Binomial theorem. (3)

2. (a) Two bond vectors in a hypothetical molecule are given by

$$\vec{a} = 2\hat{i} + \hat{j} + \hat{k}$$

$$\vec{b} = \hat{i} + 2\hat{j} + 3\hat{k}$$

Calculate $\vec{a} \times \vec{b}$ and explain what the direction of the resulting vector represents geometrically. (3)

- (b) Obtain the graph of the cosine function for $x \in [0, 2\pi]$. (3)

(c) Using the vector method, derive an expression for the angle between two bond dipoles. A hypothetical bent molecule has two identical bond dipole moments, each of magnitude 2.0 D and a resultant molecular dipole moment of 3.0 D. Calculate the angle between the two bonds. (4)

3. (a) Evaluate the following limit.

$$\lim_{x \rightarrow 0} \frac{\tan x - \sin x}{x^3} \quad (3)$$

(b) The position of a particle moving along a straight line is given by

$$s = 4 \sin t + 3 \cos t$$

i) Find its velocity and acceleration.

ii) Find the velocity at $t = \frac{\pi}{2}$.

(2+1)

(c) Find the derivative of the following functions with respect to x :

(2+2)

(i) $\ln[r \ln(5r)]$

(ii) $\frac{x^{1/2} - x^{-1/2}}{x^{1/2} + x^{-1/2}}$

4. (a) Show that the following function is a homogeneous function also calculate the degree of the function (2)

$$f(x, y) = \frac{x^{1/4} + y^{1/4}}{x^{1/5} + y^{1/5}}$$

(b) Find the equation points of maxima and minima of the function $f(x) = x^3 - 3x$. (2+2)

(c) Determine the domain in which the following functions are continuous (2+2)

(i) $f(x, y) = \sqrt{3 - 4(x^2 - y^2)}$

(ii) $f(x, y) = \ln xy$

5. (a) Find all the antiderivatives of each of the following function: (2x2)

(i) $f(x) = \tan x$

(ii) $f(x) = 6x^4$

(iii) $f(y) = \sqrt{y}$

(iv) $f(z) = 5z + 4$

(b) Evaluate the following integrals: (3x2)

(i) $\int \sin^3\left(\frac{2}{3}x\right) \cos^4\left(\frac{2}{3}x\right) dx$

(ii) $\int \frac{(\ln x)^2}{x} dx$

(iii) $\int_1^5 f(x) dx$; where $f(x) = \begin{cases} 2x + 4; & 1 \leq x < 3 \\ x^3 + 1; & 3 \leq x \leq 5 \end{cases}$

6. (a) Solve the following differential equations: (3x1)

(i) $x \frac{dy}{dx} = x \tan x \frac{y}{x} + y$

(ii) $x^2 y dy + (x^3 + x^2 y - 2xy^2 - y^3) dx = 0$

(iii) $\frac{d^2 y}{dx^2} - 3 \frac{dy}{dx} - 10y = 0$

(b) Solve the following differential equation: (3)

$$(x + 2y^3) \frac{dy}{dt} = y$$

(d) Derive all four Maxwell's relations using the following 1st law of thermodynamics equation.

$$dU = TdS - PdV$$

(4)

7. (a) Prove that the following matrix A is a unitary matrix (2)

$$A = \begin{bmatrix} 1+i & -1+i \\ 1+i & 1-i \end{bmatrix}$$

(b) Verify that the following matrix A is orthogonal (3)

$$A = \frac{1}{3} \begin{bmatrix} 2 & -2 & 1 \\ 1 & 2 & 2 \\ 2 & 1 & -2 \end{bmatrix}$$

(c) Solve the following system of equations using Cramer's rule. (5)

$$x + y + z = 6$$

$$y + 3z = 11$$

$$x + z = 2y$$

8. (a) If $\begin{bmatrix} 3 & x+y \\ xy & 7+z \end{bmatrix} = \begin{bmatrix} 3 & 6 \\ 8 & 4 \end{bmatrix}$, find the values of x, y and z . (2)

(b) Find the eigenvalues of the matrix

$$A = \begin{bmatrix} 2 & 2 & -2 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$$

(3)

(c) For the given matrix A and B

$$A = \begin{bmatrix} 2 & 3 \\ -1 & 4 \end{bmatrix} \text{ and } B = \begin{bmatrix} 1 & 4 \\ 5 & -2 \end{bmatrix}$$

verify the result $(AB)^{-1} = B^{-1}A^{-1}$. (5)

9. (a) In how many different ways can five persons be seated around a circular table if two particular persons must always sit together? (2)

(b) A number is chosen at random from the first 50 natural numbers. Calculate the probability that the selected is divisible by 3 or 8. (2)

(c) Probabilities that students A, B and C solve a randomly selected problem from a book are $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$, respectively. If a randomly selected problem from the book is given to these students, then what is the probability that problem is solved. (3)

(d) The number of calls received by a telephone exchange in a 5-minute interval follows a Poisson distribution with mean 6 calls. Find the probability that in a randomly selected 5-minute interval, the exchange receives more than 4 but fewer than 8 calls. (3)

10. (a) Three quantities are to be summed up as $y = a + b - c$. The individual absolute standard deviations of the three quantities are given in parentheses. Calculate the standard deviation of the arithmetic operation and express the result of summation.

$$a = 2.50 (\pm 0.02); b = 3.10 (\pm 0.03); c = 1.97 (\pm 0.05) \quad (4)$$

(b) In an experiment, the following concentration values (in mol/L) of a solution were measured:

0.102, 0.100, 0.098, 0.101, 0.099

Calculate the mean, variance, standard deviation, standard deviation of the mean (standard error), coefficient of variation (in %) and the relative standard deviation expressed in ppm of the concentration.

(6)