ASSIGNMENT BOOKLET

Post Graduate Diploma in Analytical Chemistry (PGDAC)

Basic Analytical Chemistry	**(MCH – 001)**
Separation Methods	**(MCH – 002)**
Spectroscopic Methods	**(MCH – 003)**
Electroanalytical & Other Methods	**(MCH – 004)**

(Valid from January 1, 2025 to December 31, 2025)

It is compulsory to submit the assignments before filling in the examination form.

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068
(2025)

Dear Learner,

This assignment booklet consists of the tutor marked assignments (TMAs) of MCH-001, MCH-002, MCH–003 and MCH–004 courses of the Post Graduate Diploma in Analytical Chemistry (PGDAC) programme.

We hope, you are familiar with the system of evaluation to be followed for this programme. You may probably like to re-read the section on assignments in the Programme Guide that was sent to you earlier. As you are aware, a weightage of 30 percent has been earmarked for continuous evaluation component. For this you have to submit the responses of the enclosed tutor marked assignments to the Study Centre Coordinator. The assignments are based on the content of all the blocks of all the courses.

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

1 On top of the first page of your assignment response, please write the details exactly in the following format; write your answers from second page onwards.

ENROLMENT NO. : ……...

NAME **:** ……

ADDRESS **:** ……...

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COURSE CODE **:** ……

COURSE TITLE **: ……..**

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 While writing answers, clearly indicate the Question No. and part of the question being solved.

6 Though the validity of assignment is for one year, we advise you to submit the assignment response within 12 weeks after receiving it.

7 **We strongly suggest that you should retain a copy of your assignment responses.**

Wishing you good luck

Tutor Marked Assignment

MCH-001: Basic Analytical Chemistry

Course Code: MCH-001
Assignment Code: MCH-001/TMA/2025
Maximum Marks: 100

Note: Answer all the questions given below.

1 a) Explain Coulometric analysis and Potentiometric analysis. (5)

b) What are the three major contributions in the present vitality of analytical chemistry? How it has helped in saving time? (5)

2 a) What are indeterminate errors? How can they be prevented? (5)

b) 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: a = 50.23($\pm$0.07), b = 27.86 ($\pm$0.05) and c=0.1167($\pm$0003). Calculate the standard deviation of the arithmetic operation and express with absolute uncertainty. (5)

3 a) What are Grab or catch samples? How is it different from integrated samples? (5)

b) Give the classification of the sampling methods for gaseous pollutants. In this context, when absorption is done in liquids then what is the collection efficiency? (5)

4 a) Why is it essential to consider the safety aspect at the time of the construction of the laboratory building? List any three requirements that must be met as per the norms in a chemical laboratory. (5)

b) What sort of first aid should be provided after chemicals are accidentally ingested in the laboratory? (5)

5 a) What is the proportional equation method for measurement of reaction rates? (5)

b) Write the chemical equations for the leveling of $HClO_4$, HCl and HNO_3 in methanol. Also give the steps in which phosphoric acid dissociates. (5)

6 a) What is indicator error? How the indicator should be selected for a given titration? (5)

b) Calculate the pH of a solution prepared by adding 25 cm^3 of 0.20 M NaOH to 30 cm^3 of 0.40 M acetic acid. (5)

7 a) Calculate the redox potential of Sn^{4+}, Sn^{2+} system, if the Sn^{4+} ion concentration is 1 g ion/dm^3 and the Sn^{2+} ion concentration is 0.001 g ion/dm^3. (5)

b) What are the factors that affect stability of metal-ligand complexes? Elaborate on any two of them. (5)

8 a) What are the key steps in designing a typical complexometric determination? How are they advantageous over precipitation titrations? (5)

b) Lead-EDTA chelate having the formula PbY^{2-} has a formation constant of $1.1X10^{14}$. Compute the conditional formation constants at a pH = 10. (value of $\alpha_{Y^{4-}}$ at pH of 10 is 0.36). (5)

9 a) Give the curve for precipitation titration of Br^- with Ag^+. Explain it. (5)

b) Explain supersaturation and nucleation in context with gravimetric analysis. (5)

10 a) Briefly describe the role of computers in analytical instrumentation. (5)

b) What is inductively coupled plasma (ICP)? What are the two types of ICP instruments? Can you determine all elements by ICP? (5)

Tutor Marked Assignment

MCH-002: Separation Methods

Course Code: MCH-002
Assignment Code: MCH -002/TMA/2025
Maximum Marks: 100

Note: Answer all the questions given below.

1.	Briefly explain the separation methods based on surface activity.	(5)
2.	Discuss various criteria used for the selection of separation methods.	(5)
3.	Explain percentage extraction. Derive the expression for it.	(5)
4.	Describe salient features of extractions using crown ethers.	(5)
5.	With the help of suitable examples, describe the extraction of anionic metal complexes by high molecular weight amines.	(5)
6.	Discuss the role of masking agents in solvent extraction.	(5)
7.	Brief explain the concept of theoretical plates.	(5)
8.	Draw van Deemter plot. What conclusions can be drawn on the basis of reducing zone broadening?	(5)
9.	Enlist any five characteristics of ideal support material for liquid-liquid partition chromatography.	(5)
10.	Discuss frontal analysis development technique for liquid column chromatography.	(5)
11.	List any ten differences between paper chromatography and thin layer chromatography.	(5)
12.	Which different factors make the results of TLC difficult to reproduce?	(5)
13.	Briefly explain various interaction forces which can aid in GC separation.	(5)
14.	List the requirements of a liquid phase used in gas chromatography.	(5)
15.	Compare the important aspects of GC and HPLC.	(5)
16.	Discuss different types of capacities of an ion exchanger.	(5)
17.	Explain the unique features of size exclusion chromatography.	(5)
18.	What are ion selective electrodes? Explain their use and applications.	(5)
19.	Discuss important aspects of Knudsen flow.	(5)
20.	Discuss the reagents and instruments used for electrophoresis.	(5)

Tutor Marked Assignment
MCH-003: Spectroscopic Methods

Course Code: MCH-003
Assignment Code: MCH-003/TMA/2025
Maximum Marks: 100

Note: Answer all the questions given below.

1. a) Define electromagnetic radiation in terms of the wave mechanical model. State the necessary condition for a molecule to show IR spectrum. Will HCl show IR spectrum? (5)

   b) The transmittance of a solution, containing 7.3 mg of potassium dichromate per 100 cm^3, taken in a cuvette of path length of 1 cm is measured at 455 nm. If the percentage transmittance found to be 6, calculate the molar absorptivity of the oxidizing agent. (5)

2. a) What are monochromators? Describe the working of a grating monochromator. In what way is the standard addition method of calibration in UV-VIS spectrophotometry better than the standard solution method? (5)

   b) Explain the origin of Raman spectrum in terms of quantum theory of radiation. State the 'Rule of mutual exclusion'. What is its significance? (5)

3. a) Explain the origin of fluorescence and phosphorescence spectra in terms of Jablonski diagram. What is meant by fluorescence quenching? How does it affect the quantum yield of a fluorescence emission? (5)

   b) The experimental set up for the fluorescence spectral measurement is different from that for the absorption measurement. Comment on the statement. Why do we need to modify the instrumental set up for the fluorescence spectrometer to make phosphorescence measurements? (5)

4. a) What is chemiluminescence? Write an analytical application of chemiluminescence in the area of environmental pollution measurement. (5)

   b) Describe the application of fluorescence measurements in medical diagnosis by taking the example of blood glucose determination. (5)

5. a) Briefly explain the origin of atomic spectrum. Explain why the atomic spectra are line spectra whereas the molecular spectra are band spectra. (5)

   b) Discuss the fate of analyte sample in the flame of a flame photometer. (5)

6. a) Explain the different types of spectral interferences observed in flame photometry. (5)

   b) Explain different pathways of atomic fluorescence emission. In what way is halogen cathode lamp (HCL) better than a continuous source for atomic fluorescence measurement? (5)

7. a) Explain the principles of atomic absorption spectrophotometry and atomic emission spectrometry. (5)

   b) Why line sources are preferred over continuum sources for AAS? Enlist the advantages of GFAAS over FAAS. (5)

8. a) Enlist different components of an ICP torch. What makes argon a good choice for the plasma gas? (5)

   b) Describe the acid digestion method of solution preparation in AES. (5)

9. a) Explain the following terms in the context of NMR spectrometry. (5)

   - Chemical shift
   - Spin-spin splitting
   - Larmour precession

   b) FT – NMR is better than CW – NMR. Comment on the statement. What is the principle of mass spectrometry? In what way is it different from other spectrometric methods? (5)

10. a) Explain Mc Lafferty rearrangement with the help of a suitable example. Calculate IHD for the molecule having the molecular formula, $C_3H_6O_2$. (5)

    b) What kind of structural information is available from UV, IR, NMR and Mass spectra of an organic compound? (5)

Tutor Marked Assignment

MCH-004: Electroanalytical and Other Methods

Course Code: MCH-004
Assignment Code: MCH-004/TMA/2025
Maximum Marks: 100

Note: Answer all the questions given below.

1. a) Derive the Nernst expression for galvanic cell. (5)

   b) What are the characteristics of a reference electrode? Describe the construction and working of a Calomel electrode. (5)

2. a) What is meant by Ion Selective electrodes? Give their applications. (5)

   b) What is the cell potential of an electrochemical cell made of a cadmium electrode in a 0.1 M $Cd(NO_3)_2$ solution and chromium electrode in a 1×10^{-4} M $Cr(NO_3)_3$ solution. (5)
   [Given: $E^0_{Cd^{2+}/Cd} = -0.40\,V$, $E^0_{Cr^{3+}/Cr} = -0.74\,V$]

3. a) Write five main features of coulometric methods. (5)

   b) What are molar conductivity and limited molar conductivity? Calculate the dissociation constant of 0.02 mol dm^{-3} ethanoic acid, if its molar conductivity is 11.57×10^{-4} S m^2 mol^{-1} and limited molar conductivity is 3.90×10^{-2} S m^2 mol^{-1}. (5)

4. a) To analyse a brass alloy, a 0.442 g sample is dissolved in acid to volume in a 500 cm^3 volumetric flask. Electrolysis of a 10 cm^3 sample at – 0.3 V vs SCE reduces Cu^{2+} to Cu, requiring total charge of 16.11 C. Adjusting the potential of 0.6 V vs SCE and completing the electrolysis requires 0.442 C to reduce Ph^{2+} to Pb. Report the percentage of Cu and Pb in the alloy. (5)

   b) What is stripping voltammetry? Taking a suitable example discuss the anodic stripping voltammetry. (5)

5. a) What are the factors affecting the diffusion current? Discuss these factors in brief. (5)

   b) How will you determine lead and copper in carbon steels using polarographic method? (5)

6. a) Discuss various sources of errors in TGA. (5)

   b) A mixture of $CaCO_3$ and CaO is analysed using TGA method. TG curve of the sample indicates that there is a mass change from 290.6 mg to 230.8 mg between 500-900°C. Calculate the percentage of $CaCO_3$ in sample. (5)

7. a) Write down any five applications of DSC technique. (5)

   b) Give the difference between thermometric and classical titrimetry. (5)

8. a) Define the unit of radioactivity, Curie (Ci) and Becquerel (Bq). Calculate the strength of 9.6 ng of ^{198}Au ($t_{1/2}$ = 2.7 d) in Curie. (5)

   b) A 0.5 cm^3 solution containing 8.5 μ Ci of ^{59}Fe was injected into the blood stream of a horse. After equilibrium, 1.0 cm^3 of blood was taken out and it gave 26448 counts in 6 minutes. Calculate the blood volume in the body of horse. (5)

9. a) Discuss the important criteria for the choice of radiotracers. Name the isotop used for the determination of Mn steel. (5)

   b) Explain methodology of radioimmunoassay and list its advantages. (5)

10. Write short notes: (10)
    a) Ionic product of water
    b) NAA
    c) Square wave polarography
    d) Ohmic potential